

Final Monitoring Plan for Site Restoration at Murdock, Nebraska

prepared by Environmental Science Division Argonne National Laboratory



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by Applied Geosciences and Environmental Management Section Environmental Science Division, Argonne National Laboratory

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Contents

No	otation	1	V
1	Intro	oduction	1-1
	1.1	Background	1-1
	1.2	Overview of the Removal Action Components	1-2
2	Base	eline Sampling Studies	2-1
	2.1	Groundwater Analysis Results	2-1
	2.2	Surface Water Analysis Results	
	2.3	Plant Tissue Analysis Results	
	2.4	Ambient Air Analysis Results	2-11
3	Reco	ommended Monitoring Programs	3-1
	3.1	Initial (Five-Year) Sampling and Monitoring.	3-1
		3.1.1 Monitoring of the Spray Irrigation Treatment System (Groundwater)	3-2
		3.1.2 Monitoring of the Phytoremediation Treatment System (Groundwater)	3-4
		3.1.3 Monitoring of the Surface Water Treatment Systems	3-6
		3.1.4 Monitoring of Contaminant Reduction in the Groundwater Plume	3-7
		3.1.5 Monitoring of Local Atmospheric Carbon Tetrachloride Levels	3-8
		3.1.6 Reporting of the Monitoring Results	3-9
	3.2	Long-Term Sampling and Monitoring	3-10
		3.2.1 Monitoring of the Spray Irrigation Treatment System and Discharge	3-10
		3.2.2 Monitoring of the Phytoremediation Treatment System	3-10
		3.2.3 Monitoring of the Surface Water Treatment Systems and Discharge	3-11
		3.2.4 Monitoring of Contaminant Reduction in the Groundwater Plume	3-12
		3.2.5 Monitoring of Local Atmospheric Carbon Tetrachloride Levels	3-12
		3.2.6 Reporting of the Monitoring Results	3-12
	3.3	Summary of Compliance Points and Compliance Values	3-13
	3.4	Investigation Methods	3-13
4	Refe	erences	4-1
Αţ	pend	ix A: Well Construction Information	A-1
Αţ	ppend	ix B: Nebraska Department of Environmental Quality Discharge Requirements for the Murdock Groundwater Treatment System	B-1

Figures

1.1	Location of Cass County and Murdock, Nebraska	1-4
1.2	Locations of the GWEX-1 well, the spray irrigation treatment area, the shallow and deep phytoremediation planting areas, and the constructed wetlands at Murdock, with the location of the former CCC/USDA grain storage facility	1-5
1.3	Traveling spray irrigation unit used to process groundwater pumped seasonally from extraction well GWEX-1 at Murdock	1-6
1.4	Distribution of trees planted in the southwestern portion of the phytoremediation treatment area at Murdock, at the headwaters of the tributary creek	1-7
1.5	Southwestern portion of the wetlands treatment area, shortly after construction and grading of the wetlands basin	1-8
2.1	Locations of groundwater and surface water samples collected for volatile organic analyses during the July 2005 baseline sampling event	2-14
2.2	Results of analyses for carbon tetrachloride in water samples collected during the July 2005 baseline sampling event	2-15
2.3	Results of analyses for carbon tetrachloride in vegetation samples collected in the surface and deep phytoremediation planting zones during the July 2005 baseline sampling event	2-16
2.4	Results of analyses for carbon tetrachloride in ambient air samples collected during the July 2005 baseline sampling event	2-17
3.1	Locations proposed for the measurement of groundwater levels through use of automated water level recorders during the initial monitoring period	3-15
3.2	Approximate locations proposed for the periodic sampling and analysis of vegetation samples for volatile organic compounds during the initial monitoring period.	3-16
3.3	Locations proposed for the periodic measurement of selected geochemical parameters in groundwater during the initial monitoring period, to identify the anticipated development of reducing/anaerobic conditions required for the microbial degradation of carbon tetrachloride by reductive dechlorination	3-17
3.4	Locations proposed for the periodic sampling of surface waters for volatile organic analyses during the initial monitoring period.	3-18
3.5	Locations proposed for the periodic sampling of groundwater for volatile organic analyses during the initial monitoring period	3-19
3.6	Locations proposed for the periodic sampling of ambient air for volatile organic analyses during the initial monitoring period	3-20
A.1	Locations of all permanent groundwater observation points at Murdock	A-2

Tables

2.1	Results of organic analyses on groundwater and surface water samples collected in the baseline sampling at Murdock, Nebraska, in July 2005	2-3
2.2	Results of organic analyses on vegetation samples collected in the baseline sampling at Murdock, Nebraska, in July 2005	2-5
2.3	Results of organic analyses on air samples collected on three consecutive days, at five locations at Murdock, in the baseline sampling in July 2005	2-12
3.1	Monitoring plan for the Murdock removal action	3-3
3.2	Reporting schedule for site restoration monitoring activities at Murdock, Nebraska	3-11
A .1	Construction data for permanent observation points at Murdock, Nebraska	A- 3

Notation

BGL below ground level

CCC Commodity Credit Corporation

CERCLA Comprehensive Environmental Response, Compensation,

and Liability Act

EE/CA Engineering Evaluation/Cost Analysis
EPA U.S. Environmental Protection Agency

ft foot (feet)

gpm gallon(s) per minute

GWEX groundwater extraction well

hr hour(s)
in. inch(es)

µg/L microgram(s) per liter

µg/m³ microgram(s) per cubic meter

mi mile(s)

USDA U.S. Department of Agriculture

VOC volatile organic compound

yr year(s)

Final Monitoring Plan for Site Restoration at Murdock, Nebraska

1 Introduction

1.1 Background

In early 2005, Argonne National Laboratory conducted an Engineering Evaluation/Cost Analysis (EE/CA; Argonne 2005b) to address carbon tetrachloride contamination identified in groundwater and surface water at Murdock, Nebraska, approximately 22 mi east-northeast of Lincoln (Figure 1.1). The EE/CA study was performed for the Commodity Credit Corporation of the U.S. Department of Agriculture (CCC/USDA), as the technical basis for a proposed removal action for the Murdock site. The EE/CA was conducted in compliance with an *Administrative Order on Consent* issued for Murdock by the U.S. Environmental Protection Agency (EPA 1991).

Three removal action alternatives were examined through the use of site-specific data and predictive simulations of groundwater flow and contaminant transport performed with calibrated numerical models. The alternatives were evaluated individually and compared against performance criteria established under the National Oil and Hazardous Substances Pollution Contingency Plan and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). On the basis of these evaluations, an alternative employing phytoremediation in conjunction with seasonal groundwater extraction and treatment by spray irrigation was recommended by the CCC/USDA to permanently reduce the carbon tetrachloride contaminant levels in groundwater and surface water at the site. The proposed alternative is being implemented in cooperation with the EPA.

Under the direction of the CCC/USDA and the EPA, implementation of the chosen removal action occurred in phases, beginning in April 2005. Installation of all the required remediation systems was completed by the end of August 2005.

Specific technical objectives of the removal action are as follows:

- To eliminate pathways for potential human exposure to carbon tetrachloride concentrations above the regulatory limit of 44.2 μ g/L in surface water at the site.
- To minimize or eliminate any detrimental environmental impacts of carbon tetrachloride discharge to the surface waters of a tributary creek located immediately north of the town.
- To permanently reduce carbon tetrachloride concentrations in the groundwater and surface water at Murdock and hence restore these resources for potential beneficial use.

To evaluate the effectiveness of the selected remedy and its ability to achieve the objectives specified for this site, monitoring is required. This document outlines the proposed scope of a long-term program for monitoring of the removal action at Murdock. In this section the specific remedial objectives of the action are summarized, and a brief overview of the chosen remedy is provided. Section 2 summarizes the results of a baseline sampling event that documented the distribution of carbon tetrachloride contamination in selected media at the Murdock site immediately before cleanup activities began. Section 3 recommends a strategy for subsequent monitoring of the removal action at Murdock, as well as criteria for evaluating the performance of the remedial systems and the progress of the restoration effort.

1.2 Overview of the Removal Action Components

The removal action implemented at Murdock involves several innovative technologies used in sequence along the plume migration pathway to decrease carbon tetrachloride levels in groundwater and in water naturally discharged to the surface at the headwaters of a small creek (a tributary to Pawnee Creek) north of the town. The primary elements of this system are (1) a groundwater extraction well and treatment unit, (2) a phytoremediation planting area, and (3) constructed wetlands (Figure 1.2).

A groundwater extraction well (GWEX-1) has been installed to remove contaminated groundwater from the upgradient, more concentrated portion of the plume. GWEX-1 is operated

seasonally at an estimated pumping rate of 35 gpm. A specially designed spray treatment apparatus (Figure 1.3) simultaneously volatilizes carbon tetrachloride from the produced groundwater and irrigates property owned by the Elmwood-Murdock Public School system.

Selected vegetation types planted in the headwaters area of the tributary creek reduce carbon tetrachloride concentrations in the relatively shallow groundwater and surface waters via phytoremediation processes. Approximately 2,000 trees, representing six species (Niobe willow, black willow, eastern cottonwood, hybrid poplar, green ash, and northern catalpa), cover an area of approximately 4.5 acres (Figures 1.2 and 1.4). Removal of the carbon tetrachloride occurs as a result of uptake, transpiration, and volatilization of the contaminated groundwater by the trees and degradation of the carbon tetrachloride within the plant tissues, as well as via enhanced microbial activity in the root zone created by the plantings. At locations where the static groundwater level is typically more than 4–5 ft below ground level (BGL), in the "deep" planting zone (Figure 1.2), a special technique was used to plant the trees in 24-in.-diameter boreholes lined with plastic sleeves. This "tree well" technique limits the availability of shallow soil water and direct precipitation to the trees, and hence it promotes vertical root growth and uptake of the deeper contaminated groundwater. In the remaining "surface" planting zone (Figure 1.2), the trees were installed without borehole liners to give the roots access to contaminated groundwater typically encountered at depths of less than 4 ft BGL.

Additional vegetation, including a mixture of native prairie grasses, wildflowers, and other species, was planted between the trees and in the adjacent areas. These cover plantings (1) enhance erosion control, (2) intercept local precipitation and runoff and hence promote the uptake of deeper contaminated groundwater by the trees, (3) help protect the trees from physical damage, (4) provide a transitional buffer zone between the tree planting area and the surrounding croplands, and (5) create a barrier to herbicide drift.

Shallow wetlands constructed downstream from the main planting area provide an additional phytoremediation "polishing" stage for the water discharged to the tributary creek (Figures 1.2 and 1.5). By increasing the local residence time and surface exposure area of the flow entering the downstream portion of the tributary, the wetlands promote further carbon tetrachloride evaporation and degradation by water-loving plants and associated microbes.

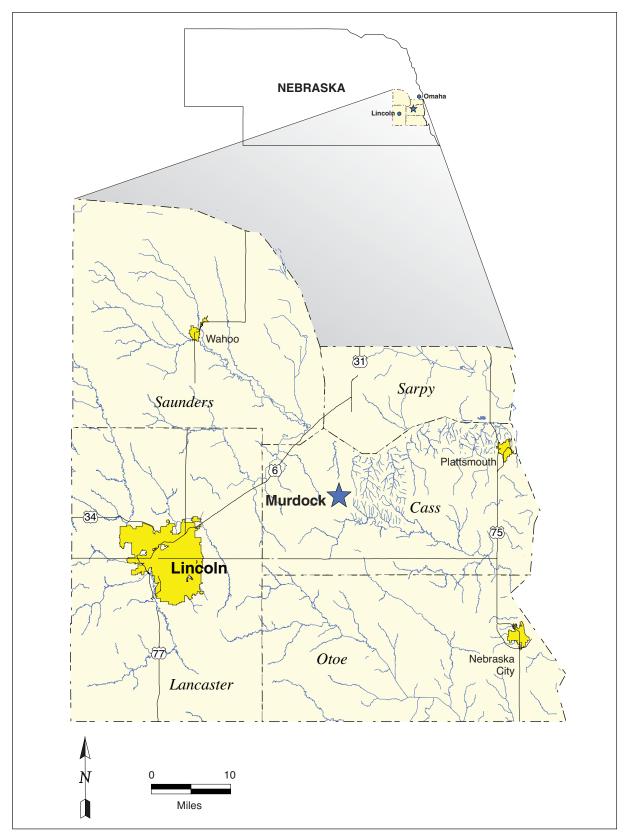


FIGURE 1.1 Location of Cass County and Murdock, Nebraska.



FIGURE 1.2 Locations of the GWEX-1 well, the spray irrigation treatment area, the shallow and deep phytoremediation planting areas, and the constructed wetlands at Murdock, with the location of the former CCC/USDA grain storage facility. Source of photograph: NAIP (2003).



FIGURE 1.3 Traveling spray irrigation unit used to process groundwater pumped seasonally from extraction well GWEX-1 at Murdock.



FIGURE 1.4 Distribution of trees planted in the southwestern portion of the phytoremediation treatment area at Murdock, at the headwaters of the tributary creek (July 2005).

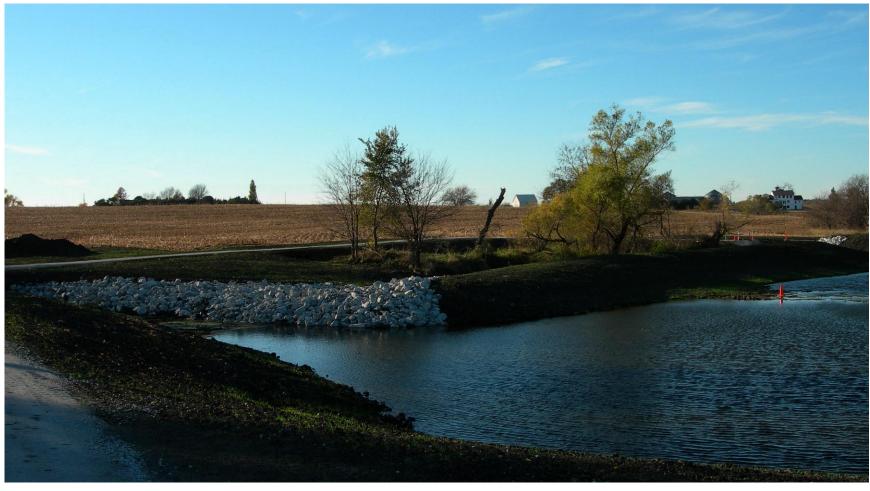


FIGURE 1.5 Southwestern portion of the wetlands treatment area, shortly after construction and grading of the wetlands basin (fall 2005).

2 Baseline Sampling Studies

An initial event to collect samples for analyses for volatile organic compounds (VOCs) was conducted at Murdock in July 2005, shortly after the groundwater extraction system was installed and the main phytoremediation areas were planted. This sampling was performed to (1) provide a current "snapshot" of the carbon tetrachloride distribution in the previously identified groundwater plume and the surface waters at the headwaters of the tributary creek and (2) establish baseline data for future comparisons that will permit evaluation of the performance of the remedial systems implemented at the site and progress toward restoration of the Murdock aquifer.

The July 2005 sampling activities included (1) groundwater and surface water sampling throughout the area affected by the carbon tetrachloride plume, (2) tissue sampling of the newly planted vegetation in the phytoremediation area, and (3) ambient air sampling in the planted and preexisting vegetated areas along the tributary creek. The results of these analyses are summarized below.

2.1 Groundwater Analysis Results

To determine current levels of carbon tetrachloride contamination in the upgradient portion of the groundwater plume, groundwater samples for VOCs analyses were collected at nine permanent observation locations along and south of Waverly Road (MW2, SB63–SB65, SB68–SB72), as well as at GWEX-1 (Figure 2.1). These observation points were installed during previous work at Murdock to facilitate periodic sampling along both the approximate central axis of the identified groundwater plume and near its lateral margins. At each of these locations, a cluster of two or more borings provides vertical resolution of the contaminant distribution within the plume. Construction information for these selected observation points, as well as for the full suite of permanent observation points available at the Murdock site, is summarized in Appendix A.

To complement the preexisting observation points, 15 new permanent observation wells were installed at 9 locations near the headwaters of the tributary creek north of Waverly Road, both in and adjacent to the phytoremediation planting area (Figure 2.1). Well clusters PMW1, PMW2, PMW9, and PMW3 were installed along a linear trend roughly following the central path of groundwater flow and contaminant migration toward the tributary creek. Wells

PMW4–PMW7 are located on an approximate transect across the contaminant plume in the area where groundwater discharge to the creek has been consistently observed, and well PMW8 is near the identified downgradient erosional limit of the Murdock aquifer (Argonne 2005a). Construction data and well registration information for these wells are in Appendix A.

The results of the groundwater analyses are summarized in Table 2.1, and the maximum carbon tetrachloride level detected at each sampling location is illustrated in Figure 2.2. The general configuration of the carbon tetrachloride plume shown in Figure 2.2 is consistent with measurements made in 2002 and 2004 (Argonne 2005a). The present data, however, provide a more detailed picture of the carbon tetrachloride distribution in the headwaters area of the tributary creek. Concentrations of carbon tetrachloride above 1,000 µg/L were detected at monitoring wells PMW1D and PMW2D, indicating that along the axis of the carbon tetrachloride plume, highly elevated levels of the contaminant are now approaching the phytoremediation planting area.

Two additional groundwater samples were collected from within the root system at two of the deep tree planting locations (W410 and W103, Figure 2.2), through vertical ventilation tubes installed for root aeration in each of the tree wells. Carbon tetrachloride was found at tree well W410 but was not detected at tree well W103 (Table 2.1). These results suggest that some uptake of contaminated groundwater by the trees at W410 began before baseline sampling. The high ratio of chloroform to carbon tetrachloride (31 μ g/L versus 38 μ g/L, respectively) at this location suggests that some degradation of carbon tetrachloride also preceded the baseline sampling.

2.2 Surface Water Analysis Results

One surface water sample was collected, at location SWP13 (Figure 2.2). The estimated carbon tetrachloride concentration for this sample (351 μ g/L; Table 2.1) was similar to levels detected at this location in 2004 (Argonne 2005a). Earlier periodic sampling at this location consistently identified SWP13 as the approximate point of maximum carbon tetrachloride discharge (on the basis of measured concentrations) to the surface waters of the tributary creek.

TABLE 2.1 Results of organic analyses on groundwater and surface water samples collected in the baseline sampling at Murdock, Nebraska, in July 2005.

				Concentrat	tion (µg/L)
Location	Sample	Depth (ft BGL)	Sample Date	Carbon Tetra- chloride	Chloro- form
Groundwater	samples				
2S	MU2S-W-18308	70.5–80.5	7/18/05	85	2.5
2D	MUD2-W-18344	85–95	7/22/05	10	3.4
SB63S	MUSB63S-W-18338	23–38	7/21/05	ND ^a	ND
SB63D	MUSB63D-W-18337	36.5–51.5	7/21/05	11	ND
SB64S	MUSB64S-W-18343	30–50	7/22/05	5.2	0.7 J ^b
SB64M	MUSB64M-W-18341	48.5–68.5	7/22/05	1.2	0.2 J
SB64D	MUSB64D-W-18340	67–87	7/22/05	0.6 J	ND
SB65S	MUSB65S-W-18335	23.7–38.7	7/21/05	ND	ND
SB65D	MU65D-W-18309	38–53	7/18/05	201	1
SB68S	MUSB68S-W-18059	49–56.5	7/21/05	568	6
SB68M	MUSB68M-W-18060	57.2–67.2	7/21/05	1013	12
SB68D	MUSB68D-W-18061	67.8–77.8	7/21/05	5.4	ND
SB69M	MUSB69M-W-18062	51.9–61.9	7/21/05	845	9.8
SB69D	MUSB69D-W-18063	62.2–72.2	7/21/05	111	3.6
SB70S	MUSB70S-W-18064	50.8–58.3	7/21/05	128	4.1
SB70M	MUSB70M-W-18065	58.4–68.4	7/21/05	65	1
SB70D	MUSB70D-W-18066	68.9–78.9	7/21/05	0.5 J	ND
SB71S	MUSB71S-W-18072	53.1–60.6	7/21/05	579	6.5
SB71D	MUSB71D-W-18073	70–80	7/21/05	3.2	0.3 J
SB72S	MUSB72S-W-18069	49–56.5	7/21/05	1.3	ND
SB72M	MUSB72M-W-18070	59.7–69.7	7/21/05	1.5	ND
SB72D	MUSB72D-W-18071	70–80	7/21/05	1.5	ND
GWEX-1	MUGWEX-W-18312	47–77	7/18/05	205	2.3
TEST-1	MUTEST1-W-18311	60–65	7/18/05	81	49
PMW1S	MUPMW1S-W-18318	4.6–14.6	7/19/05	9.4	0.4 J
PMW1D	MUPMW1D-W-18313	24.6–34.6	7/19/05	1233	5.2
PMW2SB	MUPMW2SB-W-18334	4.6–14.6	7/21/05	377	6.4
PMW2D	MUPMW2D-W-18314	19.6–29.6	7/19/05	1564	4.8
PMW3S	MUPMW3S-W-18331	4.5–14.5	7/21/05	394	2.4
PMW3D	MUPMW3D-W-18316	19.5–24.5	7/19/05	801	4.9
PMW4	MUPMW4-W-18321	19.5–24.5	7/20/05	52	1.8
PMW5	MUPMW5-W-18322	4.5–14.5	7/20/05	118	1
PMW6	MUPMW6-W-18333	4.5–14.5	7/21/05	9.6	0.4 J

TABLE 2.1 (Cont.)

				Concentrat	ion (μg/L)
Location	Sample	Depth (ft BGL)	Sample Date	Carbon Tetra- chloride	Chloro- form
Groundwater	samples (Cont.)				
PMW7	MUPMW7-W-18332	14.5–19.5	7/21/05	3.5	0.6 J
PMW8	MUPMW8-W-18323	4.5–14.5	7/20/05	23	0.8 J
PMW9S PMW9M PMW9D	MUPMW9S-W-18328 MUPMW9M-W-18329 MUPMW9D-W-18315	5–9 11–15 20–30	7/20/05 7/20/05 7/20/05	10 60 4.6	14 2 0.9 J
W103 W410	MU578-W-18260 MUTW444-W-18261	5.66–7.78 Unknown	7/19/05 7/25/05	ND 38	ND 31
Surface water	samples				
SWP13	MUSWP13-W-18068	-	7/21/05	351 C ^c	10

 $^{^{\}rm a}$ ND, contaminant not detected at an instrument detection limit of 0.1 $\mu g/L$.

2.3 Plant Tissue Analysis Results

As noted in Section 1.2, the vegetation planted in the phytoremediation area is expected to take up, transpire, and degrade carbon tetrachloride as the plants take root and mature. Previous sampling of preexisting natural vegetation along the tributary creek (Argonne 2005b) indicated that these processes should result in elevated levels of carbon tetrachloride in plant tissues over time. To obtain baseline data, plant tissue samples were collected from new trees in the phytoremediation area and analyzed for VOCs.

The vegetation sampling included all six species of trees. Sampling occurred in every other row, at every fourth or fifth tree in the sampled row. Background samples were collected at two locations in nearby areas that have not been affected by the groundwater plume. Samples of branches and leaves collected in July 2005 were analyzed by a headspace technique based on a modification of EPA Method 5021-1 (http://www.epa.gov/epahome/index/). The concentrations of carbon tetrachloride and chloroform in the plant tissue samples are summarized in Table 2.2,

^b Qualifier J indicates an estimated concentration below the method quantitation limit of 1 μg/L.

^c Qualifier C indicates an estimated concentration outside the calibration range for carbon tetrachloride at zero dilution; insufficient sample for reanalysis at dilution.

TABLE 2.2 Results of organic analyses on vegetation samples collected in the baseline sampling at Murdock, Nebraska, in July 2005.

		_		ntration /kg)
Location	Sample ^a	Sample Date	Carbon Tetra- chloride	Chloro- form
Samples ir	n planting zones			
E101	MU-593-B-18379	7/19/05	ND^b	1.7
E101	MU-593-L-18378	7/19/05	ND	1.3
E106	MU-598-B-18381	7/19/05	ND	1.5
E106	MU-598-L-18380	7/19/05	ND	3.5
E111	MU-603-B-18383	7/19/05	< 1 ^c	2.1
E111	MU-603-L-18382	7/19/05	ND	1.3
E116	MU-608-B-18385	7/19/05	ND	ND
E116	MU-608-L-18384	7/19/05	ND	ND
E121	MU-613-B-18387	7/19/05	ND	ND
E121	MU-613-L-18386	7/19/05	ND	3.4
E126	MU-618-B-18389	7/19/05	ND	ND
E126	MU-618-L-18388	7/19/05	ND	ND
E129	MU-633-B-18395	7/19/05	ND	ND
E129	MU-633-L-18394	7/19/05	ND	3.2
E245	MU-638-B-18397	7/19/05	ND	ND
E245	MU-638-L-18396	7/19/05	ND	1.3
E304	MU-690-B-18483	7/19/05	ND	1.1
E304	MU-690-L-18482	7/19/05	ND	3.4
E309	MU-695-B-18485	7/19/05	43.2	12.3
E309	MU-695-L-18484	7/19/05	ND	2.0
E314	MU-700-B-18487	7/19/05	ND	2.6
E314	MU-700-L-18486	7/19/05	ND	2.2
E319 E319	MU-705-B-18489 MU-705-L-18488	7/19/05 7/10/05	ND ND	1.4 ND
E324	MU-710-B-18491	7/19/05 7/20/05	ND	2.3
E324	MU-710-L-18490	7/20/05	ND	1.3
E329	MU-715-B-18493	7/20/05	ND	< 1
E329	MU-715-L-18492	7/20/05	ND	< 1
E340	MU-720-B-18495	7/20/05	ND	3.1
E340	MU-720-L-18494	7/20/05	ND	1.8
E345	MU-725-B-18497	7/20/05	ND	2.1
E345	MU-725-L-18496	7/20/05	ND	3.0
E438	MU-623-B-18391	7/19/05	ND	2.0
E438	MU-623-L-18390	7/19/05	ND	ND
E502	MU-789-B-18499	7/20/05	ND	3.0
E502	MU-789-L-18498	7/20/05	ND	1.3
E507	MU-794-B-18501	7/20/05	ND	1.5
E507	MU-794-L-18500	7/20/05	ND	2.7
E512	MU-799-B-18503	7/20/05	ND	2.7
E512	MU-799-L-18502	7/20/05	ND	ND
E517	MU-804-B-18505	7/20/05	ND	ND
E517	MU-804-L-18504	7/20/05	ND	2.0
E522	MU-809-B-18507	7/20/05	ND	1.5

TABLE 2.2 (Cont.)

			Concentration (μg/kg)	
Location	Sample ^a	Sample Date	Carbon Tetra- chloride	Chloro- form
Samples in	planting zones (Cont.)			
E522 E527 E527 E527 E532 E532 E533 E537 E542 E542 E547 E550 E555 E555 E555 E555 E557 E659 E659 E700 E700 E700 E705 E710 E710 E710 E715 E715 E715 E720 E725 E725 E725 E725 E730 E735 E735 E735 E740 E740 E740 E740 E740 E740 E740 E740	MU-809-L-18506 MU-814-B-18509 MU-814-L-18508 MU-819-B-18511 MU-819-L-18510 MU-824-B-18512 MU-829-B-18515 MU-829-L-18514 MU-839-B-18517 MU-839-B-18519 MU-839-L-18518 MU-844-B-18521 MU-844-B-18521 MU-844-B-18522 MU-6000000000000000000000000000000000000	7/20/05 7/20/05		2.6 < 1 ND 3.5 ND 1.6 1.2 1.2 ND ND 2.9 2.0 ND ND 3.3 ND ND 3.3 ND ND ND 1.2 ND ND ND 1.2 ND ND 1.3 ND ND 1.4 ND ND 1.2 ND ND 1.2 N 1.2 ND 1.2 ND 1.2 ND 1.2 ND 1.2 ND 1.2 ND 1.2 ND 1.2 ND 1.2 ND 1.2 ND 1.2 ND 1.2 ND 1.2 N 1.2 ND 1.2 N 1.2 N 1.2 N 1.2 N 1.2 N 1.0 N 1.0 N 1.0 N 1.0 N 1.0 N 1.0 N 1.0 N 1.0 N 1.0 N 1.0 N 1.0 N
E758 E845 E845 E858 E858 E862 E862	MU-993-L-18552 MU-1087-B-18533 MU-1087-L-18532 MU-1082-B-18531 MU-1082-L-18530 MU-1078-B-18529 MU-1078-L-18528	7/20/05 7/20/05 7/20/05 7/20/05 7/20/05 7/20/05 7/20/05	ND ND ND ND ND ND	ND ND < 1 2.1 1.3 ND ND

TABLE 2.2 (Cont.)

		_	Concer (µg.	
Location	Sample ^a	Sample Date	Carbon Tetra- chloride	Chloro- form
Samples in	n planting zones (Cont.)			
E866	MU-1072-B-18527	7/20/05	ND	1.6
E866	MU-1072-L-18526	7/20/05	ND	ND
E871	MU-1067-B-18525	7/20/05	ND	ND
E871	MU-1067-L-18524	7/20/05	ND	ND
W103 W103 W107 W107	MU-578-B-18373 MU-578-L-18372 MU-588-B-18377	7/19/05 7/19/05 7/19/05	ND ND ND	ND < 1 1.8
W111 W111	MU-588-L-18376 MU-584-B-18375 MU-584-L-18374	7/19/05 7/19/05 7/19/05	ND 3.2 ND	1.4 4.3 1.3
W114	MU-563-B-18367	7/19/05	< 1	2.1
W114	MU-563-L-18366	7/19/05	ND	ND
W119	MU-558-B-18365	7/19/05	1.5	2.7
W119	MU-558-L-18364	7/19/05	ND	ND
W124	MU-553-B-18363	7/19/05	3.9	3.4
W124 W124 W129	MU-553-L-18362 MU-548-B-18361	7/19/05 7/19/05 7/19/05	3.9 ND 3.0	3.4 ND 2.9
W129	MU-548-L-18360	7/19/05	ND	ND
W134	MU-543-B-18359	7/19/05	< 1	< 1
W134	MU-543-L-18358	7/19/05	ND	ND
W139	MU-538-B-18357	7/19/05	ND	ND
W139	MU-538-L-18356	7/19/05	ND	1.2
W144	MU-533-B-18355	7/19/05	ND	1.5
W144	MU-533-L-18354	7/19/05	ND	1.7
W148	MU-529-B-18353	7/19/05	ND	< 1
W148	MU-529-L-18352	7/19/05	ND	1.8
W153	MU-524-B-18351	7/19/05	ND	ND
W153	MU-524-L-18350	7/19/05	ND	2.8
W158	MU-519-B-18349	7/19/05	< 1	ND
W158	MU-519-L-18348	7/19/05	ND	ND
W203	MU-573-B-18371	7/19/05	ND	ND
W203	MU-573-L-18370	7/19/05	ND	ND
W210	MU-568-B-18369	7/19/05	3.7	ND
W210	MU-568-L-18368	7/19/05	ND	ND
W303	MU-462-B-18425	7/19/05	ND	ND
W303	MU-462-L-18424	7/19/05	ND	ND
W308	MU-467-B-18427	7/19/05	ND	ND
W308	MU-467-L-18426	7/19/05	ND	1.4
W361 W361	MU-301-B-18445 MU-301-L-18444	7/19/05 7/19/05 7/19/05	ND ND	ND ND
W402	MU-452-B-18421	7/19/05	ND	1.1
W402	MU-452-L-18420	7/19/05	ND	ND
W407	MU-447-B-18419	7/19/05	< 1	1.5
W407	MU-447-L-18418	7/19/05	ND	3.5

TABLE 2.2 (Cont.)

		_	Concei (µg	ntration /kg)
Location	Sample ^a	Sample Date	Carbon Tetra- chloride	Chloro- form
Samples ir	n planting zones (Cont.)			
W412 W412 W417 W417 W422 W422 W427 W427 W432 W437 W437 W437 W442 W447 W445 W447 W452 W452 W457 W455 W505 W505 W505 W505 W501 W601 W601 W606	MU-442-B-18417 MU-442-L-18416 MU-437-B-18415 MU-437-L-18414 MU-432-B-18413 MU-432-L-18412 MU-427-B-18411 MU-427-L-18410 MU-422-B-18409 MU-422-L-18408 MU-417-B-18407 MU-417-L-18406 MU-412-B-18405 MU-412-L-18404 MU-407-B-18403 MU-407-L-18402 MU-402-B-18401 MU-337-B-18399 MU-338-B-18429 MU-338-B-18561 MU-338-L-18428 MU-338-L-18560 MU-331-B-18433 MU-331-L-18432 MU-326-B-18435	7/19/05 7/19/05	ND	ND 1.3 < 1 ND 1.7 5.0 1.6 1.1 1.6 ND ND < 1 ND ND ND 1.6 ND ND 1.7 1.7 1.7 1.7 1.7 1.4 < 1 1.2 < 1
W606 W611 W611 W616 W616 W621 W621 W626 W626	MU-326-L-18434 MU-321-B-18437 MU-321-L-18436 MU-316-B-18439 MU-316-L-18438 MU-311-B-18441 MU-311-L-18440 MU-306-B-18442 MU-296-B-18447 MU-296-L-18446 MU-291-B-18449 MU-291-L-18448 MU-286-B-18451 MU-286-L-18450 MU-281-B-18453 MU-281-L-18452 MU-276-B-18455	7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05 7/19/05	ND ND ND ND ND ND ND ND ND ND ND ND ND N	< 1 ND 1.2 1.8 1.9 1.1 ND 1.1 1.1 ND ND ND ND ND ND ND ND ND ND ND ND ND

TABLE 2.2 (Cont.)

		_	Concer (µg.	ntration /kg)
Location	Sample ^a	Sample Date	Carbon Tetra- chloride	Chloro- form
Samples in	n planting zones (Cont.)			
W656	MU-276-L-18454	7/19/05	ND	1.8
W801	MU-133-B-18481	7/19/05	ND	ND
W801	MU-133-L-18480	7/19/05	ND	ND
W806	MU-128-B-18479	7/19/05	ND	< 1
W806	MU-128-L-18478	7/19/05	ND	2.0
W810	MU-123-B-18477	7/19/05	ND	ND
W810	MU-123-L-18476	7/19/05	ND	1.4
W815	MU-118-B-18475	7/19/05	ND	ND
W815	MU-118-L-18474	7/19/05	ND	ND
W820	MU-113-B-18473	7/19/05	ND	ND
W820	MU-113-L-18472	7/19/05	ND	2.7
W825	MU-108-B-18471	7/19/05	ND	1.1
W825	MU-108-L-18470	7/19/05	ND	1.5
W830	MU-103-B-18469	7/19/05	ND	1.1
W830	MU-103-L-18468	7/19/05	ND	1.8
W835	MU-98-B-18467	7/19/05	ND	1.0
W835	MU-98-L-18466	7/19/05	ND	ND 1.1
W840 W840	MU-227-B-18465 MU-227-L-18464	7/19/05 7/19/05	ND ND	1.1
W845	MU-222-B-18463	7/19/05 7/19/05	ND ND	3.7
W845	MU-222-L-18462	7/19/05	ND	2.9
W849	MU-217-B-18461	7/19/05	ND	< 1
W849	MU-217-L-18460	7/19/05	ND	1.8
W854	MU-212-B-18459	7/19/05	ND	2.0
W854	MU-212-L-18458	7/19/05	ND	2.0
W859	MU-207-B-18457	7/19/05	ND	2.0
W859	MU-207-L-18456	7/19/05	ND	2.3
W908	MU-9-B-18431	7/19/05	ND	ND
W908	MU-9-L-18430	7/19/05	ND	1.2
Backgroun	d samples			
Bruttig-1	MU-Bruttig-B-18563	7/20/05	ND	1.3
Bruttig-1	MU-Bruttig-L-18562	7/20/05	ND	1.6
Bruttig-2	MU-Bruttig-B-18565	7/20/05	ND	3.1
Bruttig-2	MU-Bruttig-L-18564	7/20/05	ND	2.2
Bruttig-3	MU-Bruttig-B-18567	7/20/05	ND	2.0
Bruttig-3	MU-Bruttig-L-18566	7/20/05	ND	2.5
Creek-1	MU-WCreek-B-18573	7/20/05	ND	ND
Creek-1	MU-WCreek-L-18572	7/20/05	ND	ND

TABLE 2.2 (Cont.)

		_	Concentration (µg/kg)		
Carbon Sample Tetra- Chloro- Location Sample ^a Date chloride form					
Backgroun	d samples (Cont.)				
Creek-2 MU-WCreek-B-18575 Creek-2 MU-WCreek-L-18574		7/20/05 7/20/05	ND ND	< 1 ND	
Creek-3 MU-WCreek-B-18577 Creek-3 MU-WCreek-L-18576		7/20/05 7/20/05	ND ND	1.2 3.1	

a Letter "B" in sample identifier indicates branch tissue; letter "L" indicates leaf tissue.

and the maximum carbon tetrachloride concentrations identified at each location are shown in Figure 2.3.

A total of 206 plant tissue samples were collected at 102 locations in the shallow and deep planting zones. Insignificant headspace concentrations of carbon tetrachloride ($< 1 \,\mu g/kg$) were found in most of the tissue samples. The results indicated, however, that some uptake of contaminated groundwater — by Niobe willows at six locations in the surface planting zone — had already occurred at the time of sampling. The detected carbon tetrachloride concentrations at these locations were generally low ($< 4 \,\mu g/kg$). The only exception was a concentration of 43.2 $\mu g/kg$ at location E309 (Figure 2.3).

Twelve plant tissue samples were collected at six locations in two uncontaminated "background" sites near the phytoremediation area: (1) along the western branch of the tributary creek and (2) at a private residence (Bruttig) along Waverly Road, east of the plume migration pathway (Figure 2.3). No carbon tetrachloride was found in these samples. Headspace concentrations of chloroform ranged from $< 1 \,\mu g/kg$ to $3.1 \,\mu g/kg$, reflecting apparently

 $^{^{\}rm b}$ ND, contaminant not detected at a quantitation limit of 0.1 μg/kg for carbon tetrachloride or 0.75 μg/kg for chloroform

c < 1 indicates a concentration of 0.1–0.99 μg/kg for carbon tetrachloride or 0.75–0.99 μg/kg for chloroform.</p>

ubiquitous low levels of chloroform in the natural vegetation in the vicinity of the tributary creek headwaters (Table 2.2).

2.4 Ambient Air Analysis Results

Under the existing preremedial conditions at Murdock, carbon tetrachloride may be introduced to the ambient air in the creek headwaters area as a result of both direct volatilization from the groundwater and surface water and via uptake and transpiration by the preexisting vegetation. The results discussed in Section 2.3 suggest that the phytoremediation plantings had relatively little impact on ambient air prior to the time of the baseline sampling. Increased volatilization of carbon tetrachloride to the atmosphere should occur, however, as these plantings mature.

Ambient air was collected in July 2005 at three locations in the phytoremediation zone (AM1, AM3, AM4; Figure 2.4) and at one location in the preexisting vegetation (AM2) along the part of the creek impacted by the carbon tetrachloride plume. A "background" air sample was also collected outside the plume area, along a waterway about 1,300 ft west of the town and 150 ft south of Waverly Road (AM5; Figure 2.4). The sampling was conducted by placing preevacuated canisters at 4–5 ft above ground surface (near the vegetation canopy level) and collecting ambient air over a 4-hr time period. To minimize wind effects, sampling at each location occurred during the early morning on each of three consecutive days. The air samples were shipped to Severn-Trent Laboratory in Burlington, Vermont, for VOCs analyses by EPA Method TO-15. The results are summarized in Table 2.3. The maximum concentrations of carbon tetrachloride found at each location are shown in Figure 2.4.

The results for the ambient air samples indicate that carbon tetrachloride and chloroform in the "background" samples (location AM5) were below the detection limits of $1.3~\mu g/m^3$ and $0.98~\mu g/m^3$, respectively. Air samples collected in the phytoremediation planting area (locations AM1, AM3, and AM4) also contained no detectable carbon tetrachloride or chloroform, except that one sample recovered at AM3 on one of the three sampling days had a carbon tetrachloride concentration at the detection limit of $1.3~\mu g/m^3$.

Air sampling in the preexisting vegetation area was performed at location AM2 (Figure 2.4). Previous sampling by Argonne (2005b) identified high levels of carbon tetrachloride in the tissues of mature trees growing at this location. The results for all three days of air sampling at AM2 indicated low concentrations of carbon tetrachloride in the ambient air near the creek, ranging from $1.4 \, \mu g/m^3$ to $3.5 \, \mu g/m^3$; no chloroform was detected (Table 2.3).

TABLE 2.3 Results of organic analyses on air samples collected on three consecutive days, at five locations at Murdock, in the baseline sampling in July 2005.

		Conce	ntration on	Davs 1. 2.	and 3	
	Da	ay 1	Day			y 3
	ppbv	μg/m³	ppbv	μg/m ³	ppbv	μg/m ³
Location AM1, between tre	es W507	and W508				
Dichlorodifluoromethane Chloromethane Trichlorofluoromethane Chloroform Carbon Tetrachloride Acetone Methyl Ethyl Ketone	0.55 0.5 U ^a 0.24 0.2 U 0.2 U 5 U 0.5 U	2.7 1 U 1.3 0.98 U 1.3 U 12 U 1.5 U	0.59 0.55 0.27 0.2 U 0.2 U 8.6 0.84	2.9 1.1 1.5 0.98 U 1.3 U 20 2.5	0.58 0.5 U 0.28 0.2 U 0.2 U 5 U 0.52	2.9 1 U 1.6 0.98 U 1.3 U 12 U 1.5
Location AM2, in the preex east of SWP03 and 20 ft w			east side o	of the cree	k near SW	P03,
Dichlorodifluoromethane Chloromethane Trichlorofluoromethane Chloroform Carbon Tetrachloride 1,2-Dichloropropane Toluene Acetone Methyl Ethyl Ketone n-Hexane	0.57 0.5 U 0.26 0.2 U 0.46 0.2 U 0.2 U 5 U 0.5 U 0.2 U	2.8 1 U 1.5 0.98 U 2.9 0.92 U 0.75 U 12 U 1.5 U 0.7 U	0.57 0.5 U 0.27 0.2 U 0.22 0.2 U 0.2 U 5 U 0.59 0.2 U	2.8 1 U 1.5 0.98 U 1.4 0.92 U 0.75 U 12 U 1.7 0.7 U	0.57 0.96 0.28 0.2 U 0.55 0.68 0.52 11 0.92 0.33	2.8 2 1.6 0.98 U 3.5 3.1 2 26 2.7 1.2
Location AM3, east of the	creek betv	veen trees l	E423 and E	528		
Dichlorodifluoromethane Chloromethane Trichlorofluoromethane Chloroform Carbon Tetrachloride Toluene Methyl Ethyl Ketone n-Hexane	0.59 0.5 U 0.26 0.2 U 0.2 0.2 U 0.59 0.2 U	2.9 1 U 1.5 0.98 U 1.3 0.75 U 1.7 0.7 U	0.58 0.51 0.27 0.2 U 0.2 U 0.2 U 0.53 0.2 U	2.9 1.1 1.5 0.98 U 1.3 U 0.75 U 1.6 0.7 U	0.58 0.5 U 0.36 0.2 U 0.2 U 0.43 0.5 U 0.25	2.9 1 U 2 0.98 U 1.3 U 1.6 1.5 U 0.88

TABLE 2.3 (Cont.)

	Concentration on Days 1, 2, and 3										
	D	Day 1		ay 2	Day 3						
	ppbv	μg/m ³	ppbv	μg/m ³	ppbv	μg/m ³					
Location AM4, west of the	creek bet	ween trees	: W635 and	d W636							
Dichlorodifluoromethane	0.59	2.9	0.58	2.9	0.6	3					
Chloromethane	0.53	1.1	0.5 U	1 U	0.53	1.1					
Trichlorofluoromethane	0.26	1.5	0.26	1.5	0.3	1.7					
Methylene Chloride	0.5 U	1.7 U	0.5 U	1.7 U	0.77	2.7					
Chloroform Carbon Tetrachloride	0.2 U 0.2 U	0.98 U 1.3 U	0.2 U 0.2 U	0.98 U 1.3 U	0.2 U 0.2 U	0.98 U 1.3 U					
Benzene	0.2 U	0.64 U	0.2 U	0.64 U	0.2 0	1.30					
Toluene	0.2 U	0.04 U 0.75 U	0.2 U	0.04 U 0.75 U	2	7.5					
Xylene (<i>m</i> -, <i>p</i> -)	0.2 U	0.73 U 0.87 U	0.2 U	0.73 U 0.87 U	0.33	1.4					
Methyl Ethyl Ketone	0.66	1.9	0.67	2	1.7	5					
2,2,4-Trimethylpentane	0.00 0.2 U	0.93 U	0.07 0.2 U	0.93 U	0.25	1.2					
<i>n</i> -Hexane	0.2 U	0.7 U	0.2 U	0.7 U	0.8	2.8					
Xylene (total)	0.2 U	0.87 U	0.2 U	0.87 U	0.34	1.5					
Location AM5, a backgrou about 150 ft south from the				ast edge o	f the water	way,					
Dichlorodifluoromethane	0.61	3	0.59	2.9	0.58	2.9					
Chloromethane	0.5 U	1 U	0.59	1.2	0.53	1.1					
Trichlorofluoromethane	0.26	1.5	0.26	1.5	0.33	1.9					
Methylene Chloride	0.5 U	1.7 U	0.5 U	1.7 U	5.7	20					
Chloroform	0.2 U	0.98 U	0.2 U	0.98 U	0.2 U	0.98 U					
Carbon Tetrachloride	0.2 U	1.3 U	0.2 U	1.3 U	0.2 U	1.3 U					
Trichloroethene	0.2 U	1.1 U	0.2 U	1.1 U	0.2	1.1					
1,2-Dichloropropane	0.2 U	0.92 U	0.2 U	0.92 U	0.46	2.1					
Toluene	0.2 U	0.75 U	0.2 U	0.75 U	6.3	24					
Xylene (<i>m</i> -, <i>p</i> -)	0.2 U	0.87 U	0.2 U	0.87 U	0.27	1.2					
Styrene	0.2 U	0.85 U	0.2 U	0.85 U	0.21	0.89					
Acetone	5 U	12 U	12	29	16	38					
Cuclohexane	0.2 U	0.69 U	0.2 U	0.69 U	0.54	1.9					
Methyl Ethyl Ketone	0.54	1.6	1.1	3.2	3	8.8					
<i>n</i> -Hexane	0.2 U	0.7 U	0.2 U	0.7 U	3.5	12					
Xylene (total)	0.2 U	0.87 U	0.2 U	0.87 U	0.28	1.2					

^a Qualifier U indicates that the contaminant was not detected at indicated reporting limit.



FIGURE 2.1 Locations of groundwater and surface water samples collected for volatile organic analyses during the July 2005 baseline sampling event. Source of photograph: NAIP (2003).

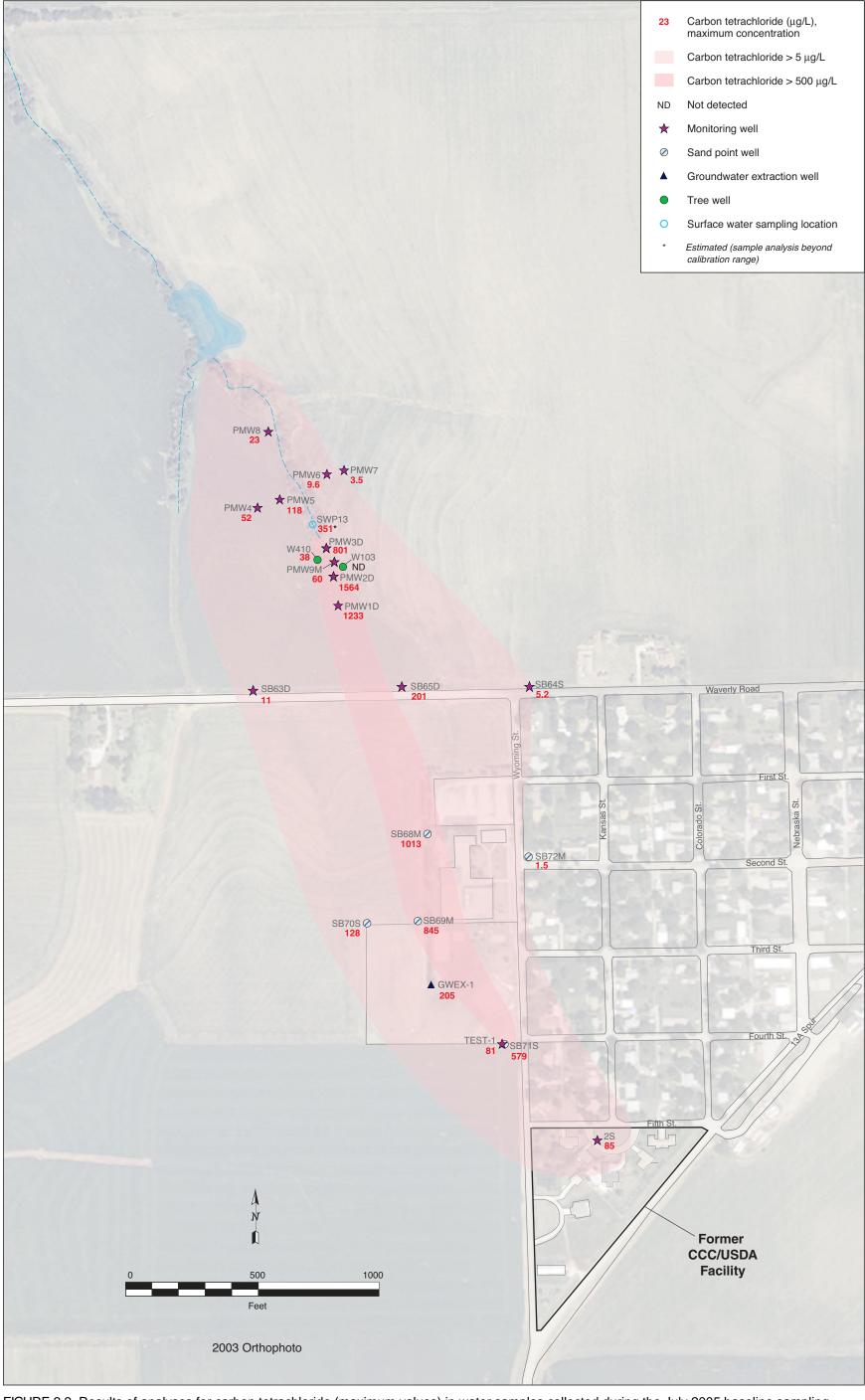


FIGURE 2.2 Results of analyses for carbon tetrachloride (maximum values) in water samples collected during the July 2005 baseline sampling event. Source of photograph: NAIP (2003).

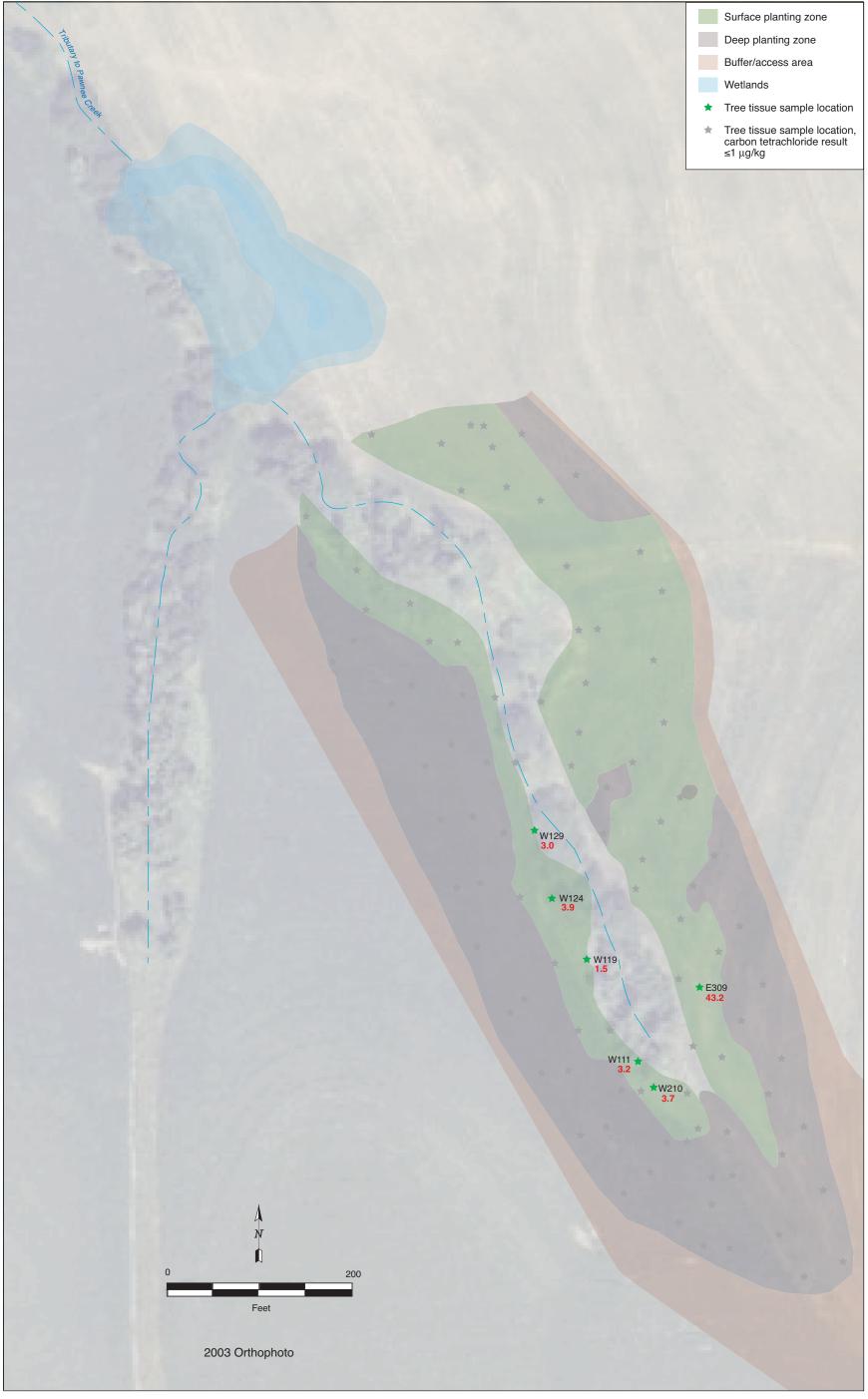


FIGURE 2.3 Results of analyses for carbon tetrachloride (maximum values) in vegetation samples collected in the surface and deep phytoremediation planting zones during the July 2005 baseline sampling event. Source of photograph: NAIP (2003).

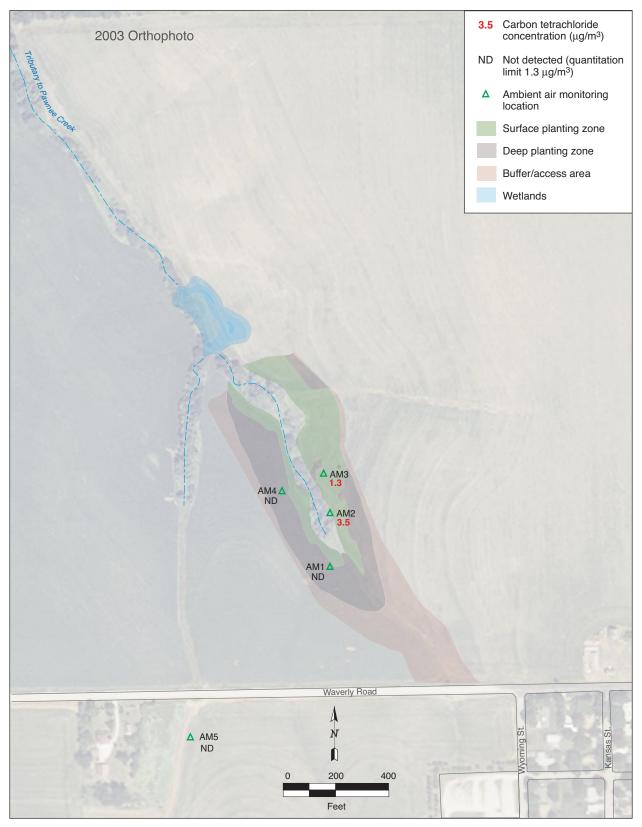


FIGURE 2.4 Results of analyses for carbon tetrachloride (maximum values) in ambient air samples collected during the July 2005 baseline sampling event. Source of photograph: NAIP (2003).

3 Recommended Monitoring Programs

Restoration of the groundwater and surface waters at Murdock is expected to occur over a period of approximately 30 yr or more under the selected removal action described in Section 1 (Argonne 2005b). An initial period of approximately 5 yr is expected to be required for the vegetation introduced in the phytoremediation plantings and constructed wetlands to reach maturity and hence to attain full design capabilities for the uptake and removal of carbon tetrachloride from groundwater and surface water. During this initial period, the remedial effectiveness of the combined treatment systems is therefore expected to increase progressively.

This section outlines two phases of sampling and monitoring of groundwater, surface water, and remedial systems recommended for the Murdock site. During each phase, the monitoring efforts are targeted to address the following specific goals, in keeping with the technical objectives of the removal action outlined in Section 1.1:

- To verify and document the performance of the remediation systems.
- To monitor the migration of the remaining carbon tetrachloride contamination and evaluate the progress of the site restoration.
- To ensure the protection of human health and the environment.

The sampling and monitoring activities proposed here were developed to provide technically defensible data of the type and quantity that are generally consistent with removal actions regulated by the EPA (under CERCLA) or by the Nebraska Department of Environmental Quality (NDEQ), and that are in keeping with the applicable or relevant and appropriate requirements identified for the Murdock site in Appendix A of the EE/CA (Argonne 2005b).

3.1 Initial (Five-Year) Sampling and Monitoring

Approximately 5 yr may be required for the phytoremediation and constructed wetlands components of the Murdock remedial systems to attain their full groundwater and surface water treatment capacity. During this period, the seasonal patterns of groundwater extraction, spray irrigation treatment, and use by the Elmwood-Murdock Public Schools will also be generally

established. Relatively intense sampling and monitoring are therefore proposed to evaluate and document the performance of these systems for treatment of the carbon tetrachloride contamination. Additional sampling is recommended to assess the progress of the combined treatment efforts in reducing carbon tetrachloride concentrations in the groundwater and surface waters at Murdock. The activities proposed for implementation during the initial (5-yr) period of monitoring at the site are summarized in Table 3.1.

3.1.1 Monitoring of the Spray Irrigation Treatment System (Groundwater)

With the approval of the EPA and the NDEQ, GWEX-1 and the associated spray irrigation treatment unit at Murdock are to be operated seasonally, at the discretion of the Elmwood-Murdock Public School system, for the irrigation of school property. The operations are to be performed in accord with a statement of discharge requirements issued by the NDEQ for these facilities (NPDES Tracking No. NE0137464; Appendix B).

In keeping with the NDEQ requirements, samples of the treated groundwater sprayed from the irrigation unit will be collected quarterly during periods of active use and analyzed for carbon tetrachloride, chloroform, and pH levels. Procedures to be used for sampling and analyzing the discharged spray were previously documented (Argonne 2000, 2004). These procedures are in use at Utica, Nebraska, and are accepted by the NDEQ. The results of the analyses are to be reported quarterly. Coincident with each spray sampling event, samples of the untreated groundwater supplied to the treatment unit will also be collected and analyzed for VOCs to enable determination of the carbon tetrachloride removal efficiency of the spray irrigation unit.

Cumulative groundwater production from GWEX-1 will be recorded by using a totalizing flow meter. The results will be used in conjunction with the groundwater and spray analysis data to estimate the quantities of carbon tetrachloride (and chloroform) removed from the aquifer by GWEX-1 and treated by the spray irrigation unit.

The NDEQ has identified the outfall from the spray irrigation unit as a land application (Appendix B). No specific target concentrations for the removal of carbon tetrachloride (or chloroform) by the spray irrigation treatment unit at Murdock are therefore established in the NDEQ's discharge requirements; only the actual concentrations discharged to the surface need to

TABLE 3.1 Monitoring plan for the Murdock removal action.

		Measurement Parameter and Frequency in Initial Five Years of Monitoring ^a						Long-Term Measurement Parameter and Frequency ^a					
		Qua	arterly	Twice Yearly		End of Five Years		Qua	arterly	Annual		Every Five Years	
Location	Continuous Automated Water Level	Manual Water Level	VOCs in GW(Sp), SW	VOCs in Air, GW(Ph), GW(PI), Veg	Geochem in GW(Ph) ^b	VOCs in GW(Ph), GW(PI)		Manual Water Level	VOCs in GW(Sp), SW	VOCs in GW(Ph), Veg	Geochem in GW(Ph) ^b	VOCs in GW(Ph), GW(PI)	
Extraction-Spray	Irrigation Sys	tem (Grou	ndwater)										
Extraction-Opray	irrigation dys	terri (Grou	nawaterj										
GWEX-1			xc			Х			Х				
Spray Unit Discharge			хc						х				
Phytoremediation	n Treatment A	rea (Veget	ation)										
Figure 3.2 ^d				Х						Х		Х	
Phytoremediation	n Treatment A	rea (Groun	dwater)				_						
DMMA/4.C	.,												
PMW1S PMW1D	X			X		X	-	X		X		X	
PMW2SA	X X			X X	Х	X X	-	X		X X	xe	X	
PMW2D	X	<u> </u>		X	X	X		X		X	x _e	x	
PMW3S	X			X	X	X		X		X	x _e	X	
PMW3D	X			X	X	X		X		X	xe	X	
PMW4	X			X	•	Х		X		X		X	
PMW5	Х			Х	Х	Х		Х		Х	xe	Х	
PMW6	Х			Х	Х	Х		Х		Х	хe	Х	
PMW7	Х			Х		Х		Х		Х		Х	
PMW8	Х			Х	Х	Х		Х		Х	xe	Х	
PMW9S	Х			Х	Х	Х		Х		Х	хe	Х	
PMW9M				Х		Х				Х	Α	Х	
PMW9D W103	Х			X	X	X		Х		X	x _e	X	
W410				X X	X X	X X				X X	x _e	X X	
Phytoremediation SWM1 SWM2 SWM3	n and Wetland	s Treatme	nt Areas (Su X X X	urface Water)					X X X				
Phytoremediation	n and Wetland	s Treatme	nt Areas (An	nbient Air) ^g				•					
AA1				Х						xe			
AA2				Х						хe			
AA3				X						хe			
BA1				Х						xe			
Upgradient Plum	e Area (Group	dwater)						<u> </u>					
opgradioner idm	S 7 11 Ca (Ground	arrator)											
1S, 1D		Х				Х		Х				х ^ј	
2S, 2D	x ^h	χ ⁱ		Х		Х		Х		х ^j		х ^ј	
3S, 3D		Х				Х		Х				χ ^j	
4S, 4D		Х				Х		Х				Хj	
MW06		Х				Х		Х				хj	
TEST-1		Х		Х		Х		Х		χ ^j		х ^ј	
WP49 ^k WP51D ^k	Х	X					_	X					
WP51D* WP54 ^k		X						X					
SB63S, SB63D		X X				Х	-	X X				хj	
SB64S,		^				^	-					۸,	
SB64M, SB64D		х				Х		х				$\mathbf{x}^{\mathbf{j}}$	
SB65S, SB65D	x ^h	x ⁱ		Х		Х		X		х ^ј		x ^j	
SB68S,													
SB68M, SB68D				х		Х				х ^j		х ^j	
SB69M, SB69D						Х						х ^j	
SB70S,												, i	
SB70M, SB70D SB71S,						Х	-					хj	
SB71S, SB71M, SB71D				х		х				х ^ј		хj	
SB72S,						X						x ^j	
SB72M, SB72D													

^a Abbreviations: Geochem, geochemistry; GW(Ph), groundwater in phytoremediation area; GW(Pl), groundwater in upgradient plume area; GW(Sp), groundwater in extraction well–spray irrigation system; SW, surface water; Veg, vegetation; VOCs, volatile organic compounds.

b Measurements will include dissolved oxygen, redox potential, and concentrations of Fe²⁺ and breakdown products. Additional parameters will be included if required (see Section 3.1.2).

 $^{^{\}mbox{\scriptsize c}}$ Additional measurements will include pH, volume produced, and volume discharged.

^d Initial sampling will be in early spring and early fall, at locations depicted in Figure 3.2. Long-term sampling will be in early fall, at selected locations to be determined.

^e Measurements are subject to verification of need during the initial 5-yr monitoring period.

f SWM3 is recommended as the compliance point for overall system discharge. The recommended compliance level is a carbon tetrachloride concentration of 44.2 μg/L in surface water.

^g Ambient air sampling will occur in early spring and near the peak of the vegetation growth cycle. Background location BA1 is southwest and upgradient/upstream of the tributary headwaters area.

h Data logger will be in the deep well at this location.

ⁱ Manual measurements will be made in the shallow well at this location.

Locations are subject to change as the configuration of the groundwater plume evolves over time.

^k Critical temporary piezometers for water level monitoring; permission to retain these piezometers is being requested.

be reported. The NDEQ document qualitatively notes, however, that the discharge may not be toxic to aquatic life in surface waters of the state outside the mixing zones allowed in NDEQ Title 117 — Nebraska Surface Water Quality Standard. This standard defines a carbon tetrachloride concentration of 44.2 μ g/L as the maximum acceptable level for the chronic exposure of aquatic life in surface waters. A maximum target concentration of 44.2 μ g/L is therefore proposed as the quantitative evaluation criterion for assessment of the spray irrigation treatment system's performance at Murdock.

3.1.2 Monitoring of the Phytoremediation Treatment System (Groundwater)

Carbon tetrachloride removal from the Murdock aquifer within the phytoremediation treatment area is expected to occur through the combined effects of

- Hydraulic "pumping" of the contaminated groundwater as a result of plant uptake,
- Transpiration and degradation of carbon tetrachloride within plant tissues, and
- Enhanced microbial degradation (reductive dechlorination) in the root zone created by the plants.

The effectiveness of each of these removal processes is expected to increase as the phytoremediation plantings approach maturity.

Evidence of Hydraulic "Pumping" Effects. To monitor for direct evidence of hydraulic "pumping" effects in the phytoremediation area during the developmental period, a water level measuring network of 16 observation points with automated water level recorders is proposed (Figure 3.1 and Table 3.1). The recorders will be programmed to collect measurements at a relatively high frequency (approximately hourly) and will be downloaded quarterly to permit analysis of the accumulated data. The automated monitoring will facilitate the detection of potential diurnal or seasonal fluctuations in groundwater levels associated with cyclic use of water by the plants, as well as potential longer-term, cumulative trends in depression of the local groundwater levels over time. The results, together with data collected from the weather station on the site, will serve as the basis for quantitative estimation of groundwater withdrawal rates by the phytoremediation plantings.

To further document the patterns of groundwater flow into the phytoremediation treatment area, the automated water level readings will be supplemented by quarterly manual measurements at additional permanent observation points across the Murdock site (Table 3.1 and Appendix A).

Evidence of Carbon Tetrachloride Removal. To verify the removal of carbon tetrachloride from groundwater by the phytoremediation plantings, a program of vegetation sampling and analysis for VOCs is proposed. Samples of plant tissues (primarily leaf and stem materials) will be collected from selected tree locations on an approximate grid pattern (Figure 3.2) designed for representative coverage of both the surface and deep planting areas and also the range of species (see Section 1.2) installed at the site. The data will provide a quantitative, comparative basis for the evaluation of contaminant uptake by the plantings in relation to the initial vegetation sampling results presented in Section 2.3.

In light of the seasonal growth cycles associated with the phytoremediation plantings, sampling of the vegetation at approximately six-month intervals is proposed during the initial (5-yr) monitoring period: (1) in early spring, before the onset of significant plant growth, and (2) in late summer or early fall, near the end of the growing cycle. Such sampling will minimize sampling effort and costs but will effectively document the temporal patterns and net annual effects of carbon tetrachloride uptake and elimination by the phytoremediation system. Supplemental vegetation sampling may also be conducted at selected times and locations during the initial monitoring period to document the effects of specific climatic or other environmental factors on the uptake of carbon tetrachloride by the plantings. The proposed vegetation sampling will coincide (whenever possible) with GWEX-1 and spray treatment sampling described in Section 3.1.1 and with the groundwater, surface water, and air sampling activities described in Sections 3.1.3–3.1.5 (Table 3.1).

Evidence of Enhanced Microbial Degradation. Though microbial activity within the root zone created by the phytoremediation plantings is expected to augment the removal of carbon tetrachloride from the groundwater, direct measurement of the microbial activity at regular intervals is neither easy nor economical.

As a logistically viable alternative, a program of geochemical sampling and analysis of the groundwater within the phytoremediation area is proposed to monitor the anticipated development of the reducing/anaerobic conditions required for the microbial degradation of carbon tetrachloride by reductive dechlorination. This monitoring will include measurements of

dissolved oxygen content, oxidation-reduction potential, and reduced iron (Fe²⁺) levels at the locations listed in Table 3.1 and shown in Figure 3.3, in conjunction with direct analyses for possible dechlorination daughter products (chloroform, dichloromethane [methylene chloride], etc.).

If the development of reducing/anaerobic conditions is demonstrated and elevated levels of daughter products are identified, additional geochemical indicators of anaerobic microbial activity, including dissolved methane and carbon dioxide levels, nitrate/nitrite ratios, and sulfate/sulfide ratios, will also be determined. Sampling and analyses for these additional parameters will also be performed in conjunction with the sampling activities described in Sections 3.1.3–3.1.5 (Table 3.1).

3.1.3 Monitoring of the Surface Water Treatment Systems

Carbon tetrachloride levels in the surface waters of the tributary creek are expected to decrease through the effects of multiple processes, including

- Contaminant removal from the influent groundwater as a result of upgradient extraction by GWEX-1 and treatment in the phytoremediation area;
- Phytoremediation and microbial degradation at and near the surface, in the phytoremediation and wetlands treatment areas; and
- Direct evaporation, plus mixing and dilution with uncontaminated precipitation and runoff, in the phytoremediation and wetlands treatment areas.

The combined effects of these processes will determine the level of carbon tetrachloride removal achieved in the effluent surface waters released from the treatment areas to the downstream reaches of the tributary creek and hence to Pawnee Creek. To quantitatively evaluate the effectiveness of the processes, surface water sampling for VOCs analyses is recommended at three critical locations along the tributary creek, as shown in Figure 3.4 (also Table 3.1).

Sampling point SWM1, which coincides with the surface water sampling location previously designated SWP13, lies near the upgradient edge of the phytoremediation treatment area. As noted in Section 2.2, past sampling at this location consistently demonstrated the highest levels of carbon tetrachloride detected in surface waters; these levels may therefore be indicative of the maximum concentrations in groundwater seepage to the headwaters of the tributary creek.

Proposed sampling point SWM2 lies directly downstream of the phytoremediation planting area (and upstream of the wetlands) and is intended to monitor the reduction in carbon tetrachloride levels achieved in the phytoremediation treatment zone.

Sampling point SWM3 lies directly downstream of the outfall from the wetlands treatment zone, and hence it will reflect the final contaminant levels achieved in effluent from the combined treatment processes. *Location SWM3 should be considered the primary point for quantitative assessment of the net performance of the Murdock treatment efforts*, in terms of achieving carbon tetrachloride concentrations in the surface waters of the tributary creek that meet regulatory requirements for the protection of human health and the environment. A maximum target concentration of 44.2 µg/L should be adopted for this discharge, as established by the NDEQ for surface waters under NDEQ Title 117 — *Nebraska Surface Water Quality Standard*.

Quarterly sampling for VOCs is recommended at locations SWM1–SWM3. Sampling at these points (for two of the events each year) will be timed to coincide with the sampling activities described in Sections 3.1.2, 3.1.4, and 3.1.5 (Table 3.1).

3.1.4 Monitoring of Contaminant Reduction in the Groundwater Plume

Contaminant reduction in the groundwater carbon tetrachloride plume is expected to occur through the effects of multiple processes, including

- Contaminant removal as a result of upgradient extraction by GWEX-1 and downgradient treatment within the phytoremediation area; and
- Evaporation, mixing, dilution, and dispersion of carbon tetrachloride along the groundwater migration pathway.

To determine the impact of the removal action efforts on carbon tetrachloride levels in the plume, twice yearly groundwater sampling for VOCs analyses is recommended (during the initial 5-yr period) at selected points along the approximate central axis of the groundwater plume, as well as within the phytoremediation area (Figure 3.5 and Table 3.1). Past sampling demonstrated that the concentrations detected at these locations typically reflect the maximum carbon tetrachloride levels identified in groundwater along the plume migration pathway. Sampling at these points will be performed in conjunction with the sampling activities described in Sections 3.1.2, 3.1.3, and 3.1.5 (Table 3.1).

At the end of the initial 5-yr monitoring period, groundwater sampling for VOCs analyses is recommended in the full suite of permanent observation points listed in Table 3.1, to permit another delineation of the plume in keeping with the past sampling efforts at this site (documented in Figures 2.9 and 2.10 of the Murdock EE/CA [Argonne 2005b]).

3.1.5 Monitoring of Local Atmospheric Carbon Tetrachloride Levels

Atmospheric sampling and analyses for VOCs conducted as part of the Murdock baseline studies identified little or no contamination of the ambient atmosphere by carbon tetrachloride (or chloroform) in the vicinity of the tributary creek headwaters (Section 2.4), despite the documented uptake of carbon tetrachloride by the natural vegetation in this area (Argonne 2005b). The release of carbon tetrachloride to the atmosphere is expected to increase in the phytoremediation and wetlands treatment areas, however, as these areas mature. Throughout the course of the removal action, these treatment areas will remain open to the public for recreational access and to workers for the required sampling, monitoring, and maintenance activities.

To ensure that potential human exposure levels remain within acceptable levels in the treatment areas, a program of atmospheric sampling and analysis for VOCs is recommended. Sampling twice per year (once in early spring, prior to the onset of significant plant growth, and once near the peak of the seasonal growing cycle) is proposed at four locations (Figure 3.6 and Table 3.1). Air sampling locations AA1–AA3 are in the shallow and deep planting areas in the phytoremediation treatment zone and adjacent to the constructed wetlands, along the public walking paths. A fourth air sampling location (BA1) is at the "background" location sampled during the baseline studies (AM5 in the former terminology; Section 2.4). Sampling at BA1 will identify potential changes in atmospheric contaminant levels at Murdock that are unrelated to the

groundwater and surface water restoration activities near the tributary headwaters. The air samples will be collected and analyzed by using the procedures described in Section 2.4.

No enforceable regulatory criteria have been promulgated for the evaluation of carbon tetrachloride contamination in ambient outdoor air in non-occupational settings. Many guidance values have been developed, however, as maximum acceptable contaminant levels for inhalation under a variety of exposure scenarios. The Agency for Toxic Substances and Disease Registry's intermediate inhalation minimal risk level of 192 µg/m³ (http://www.atsdr.cdc.gov/toxprofiles/tp30-c2.pdf) is recommended as a conservative target concentration for ambient outdoor air sampling results. This target concentration is considered to be protective against both cancer and non-cancer health effects for workers and visitors in the treatment areas near the creek (EPA 2005).

3.1.6 Reporting of the Monitoring Results

The following reporting schedule is recommended:

- Quarterly reporting of analytical results for the spray irrigation treatment system monitoring (Section 3.1.1) to the appropriate regulatory agencies, in keeping with the discharge requirements specified for this activity (Appendix B).
- Quarterly reporting of analytical results for the surface water monitoring (described in Section 3.1.3) to the appropriate regulatory agencies to document the effectiveness of the groundwater and surface water treatment systems.
- *Annual* reporting of the full results of the sampling and monitoring programs (outlined in Sections 3.1.1–3.1.5) for the current year.
- As requested by the regulatory agencies, brief (data only) accounts of individual sampling and monitoring activities.

• At the end of the initial 5-yr monitoring period, a summary report evaluating the development of the Murdock treatment systems and assessing the performance of the monitoring programs, with a new plume delineation.

The reporting schedule is summarized in Table 3.2.

3.2 Long-Term Sampling and Monitoring

The sampling and monitoring programs outlined in Section 3.1 will be critically evaluated at the end of the initial 5-yr development period to (1) determine anticipated needs for long-term performance monitoring of the Murdock remedial systems and (2) demonstrate the progress of the removal action toward the ultimate restoration of the site. A detailed long-term monitoring program will be recommended at that time. The present expectation is that the specific activities outlined in Section 3.1 will be continued, at the revised sampling frequencies suggested below and summarized in Table 3.1.

3.2.1 Monitoring of the Spray Irrigation Treatment System and Discharge

The spray irrigation treatment system influent groundwater and effluent spray will continue to be sampled for VOCs analyses (and results will be reported) *quarterly*, or on any amended schedule required for compliance with the regulatory discharge requirements (Appendix B) established for these activities.

3.2.2 Monitoring of the Phytoremediation Treatment System

Longer-term monitoring of the phytoremediation treatment system is recommended as follows:

• *Quarterly* manual water level measurements in the network of observation points listed in Table 3.1 and Appendix A to document longer-term trends in groundwater levels.

TABLE 3.2 Reporting schedule for site restoration monitoring activities at Murdock, Nebraska.

Subject of Report	Frequency in Initial Five Years	Frequency after Year Five
Analytical results for spray irrigation system	Quarterly	Quarterly
Analytical results for surface water monitoring	Quarterly	Quarterly
Full results of sampling and monitoring for current year	Annual	Annual
Brief (data only) accounts of individual sampling and monitoring activities	As requested	As requested
Summary evaluation of development and performance, with plume delineation	At end of five years	Does not apply
Full review of monitoring results and evaluation of removal action progress, with plume delineation	Does not apply	Every five years

- *Annual* vegetation sampling, near the end of the growing season, at locations to be selected on the basis of the 5-yr reviews described above and in Section 3.2.6.
- Annual sampling of groundwater at selected locations in the phytoremediation treatment area for geochemical analyses to verify the persistence of anaerobic/reducing conditions conducive to the reductive dechlorination of carbon tetrachloride, if the results of the initial (5-yr) monitoring indicated that continued testing is warranted.

3.2.3 Monitoring of the Surface Water Treatment Systems and Discharge

Continued *quarterly* sampling of the surface waters at locations SWM1–SWM3 (Figure 3.4) is recommended, as the primary indicator of the net effectiveness of the groundwater and surface water treatment systems for restoration of the surface waters discharged to the tributary creek.

3.2.4 Monitoring of Contaminant Reduction in the Groundwater Plume

Longer-term groundwater monitoring for VOCs levels is recommended as follows:

- *Annual* groundwater sampling at the selected critical observation points identified in Figure 3.5 and listed in Table 3.1.
- *At 5-yr intervals*, groundwater sampling for VOCs analyses in the full suite of permanent observation points summarized in Table 3.1 to permit redelineation of the plume.

Modifications to the sampling points identified in Figure 3.5 may be required as the configuration of the residual plume changes over time. Such modifications will be addressed with the regulatory agencies as needed during the removal action.

3.2.5 Monitoring of Local Atmospheric Carbon Tetrachloride Levels

The utility of long-term air quality sampling at the Murdock site will be evaluated at the end of the 5-yr initial monitoring period, in consultation with the regulatory agencies. If continued monitoring is considered necessary, annual sampling for VOCs analyses, near the peak of the seasonal growing cycle, is recommended at the locations in the treatment areas and at the "background" location shown in Figure 3.6.

3.2.6 Reporting of the Monitoring Results

The following reporting schedule is recommended:

 Quarterly reporting of the spray irrigation treatment system sampling and analysis results for VOCs (subject to the NDEQ discharge requirements in Appendix B), as well as the results of the surface water sampling and analyses, to document the ongoing effectiveness of the treatment systems and to meet regulatory requirements.

- *Annual* reporting of the full results of the sampling and monitoring programs outlined in Sections 3.2.1–3.2.5 during the current year.
- Every 5 yr, full review of the monitoring results and an evaluation of the progress of the removal action toward restoration of the Murdock site, in conjunction with the plume delineation sampling proposed in Section 3.2.4.

The reporting schedule is summarized in Table 3.2.

3.3 Summary of Compliance Points and Compliance Values

The following regulatory compliance points and maximum values are recommended for the Murdock treatment systems, on the basis of the discussions in Sections 3.1.1 and 3.1.3:

- For the groundwater extraction–spray irrigation system, a compliance level of 44.2 µg/L is recommended for carbon tetrachloride in spray discharge reaching the ground surface. This level is consistent with the qualitative requirements specified for the discharge by the NDEQ (Appendix B), and it reflects the acceptable level for surface waters promulgated under NDEQ Title 117 Nebraska Surface Water Quality Standard. The discharge will be sampled quarterly, and the results will be reported quarterly.
- For the overall remediation systems, the compliance level specified under NDEQ Title 117 Nebraska Surface Water Quality Standard is a carbon tetrachloride concentration of 44.2 µg/L in surface water. The recommended compliance point is location SWM3, directly downstream of the outfall from the wetlands treatment zone. Surface water at this location will be sampled quarterly, and the results will be reported quarterly.

3.4 Investigation Methods

The sampling and analysis methods for ambient air are described in Section 2.4, and the method for sampling discharge from the spray irrigation system is cited in Section 3.1.1. Other

investigational activities will be conducted in accordance with procedures defined in the *Master Work Plan* (Argonne 2002).

Quality control requirements will be those defined in the *Master Work Plan* (Argonne 2002), with the added provision that in each sampling event, one sample from each compliance point (Section 3.3) will be analyzed by a reference laboratory using EPA Contract Laboratory Program methodology. The purpose will be additional verification of the results from Argonne's Applied Geosciences and Environmental Management Laboratory, beyond the usual requirement of verification analyses for 10% of water samples.



FIGURE 3.1 Locations proposed for the measurement of groundwater levels through use of automated water level recorders during the initial (five-year) monitoring period. Source of photograph: NAIP (2003).



FIGURE 3.2 Approximate locations proposed for the periodic sampling and analysis of vegetation samples for volatile organic compounds during the initial (five-year) monitoring period. Source of photograph: NAIP (2003).



FIGURE 3.3 Locations proposed for the periodic measurement of selected geochemical parameters in groundwater during the initial (five-year) monitoring period, to identify the anticipated development of reducing/anaerobic conditions required for the microbial degradation of carbon tetrachloride by reductive dechlorination. Source of photograph: NAIP (2003).



FIGURE 3.4 Locations proposed for the periodic sampling of surface waters for volatile organic analyses during the initial (five-year) monitoring period. Source of photograph: NAIP (2003).



FIGURE 3.5 Locations proposed for the periodic sampling of groundwater for volatile organic analyses during the initial (five-year) monitoring period. Source of photograph: NAIP (2003).

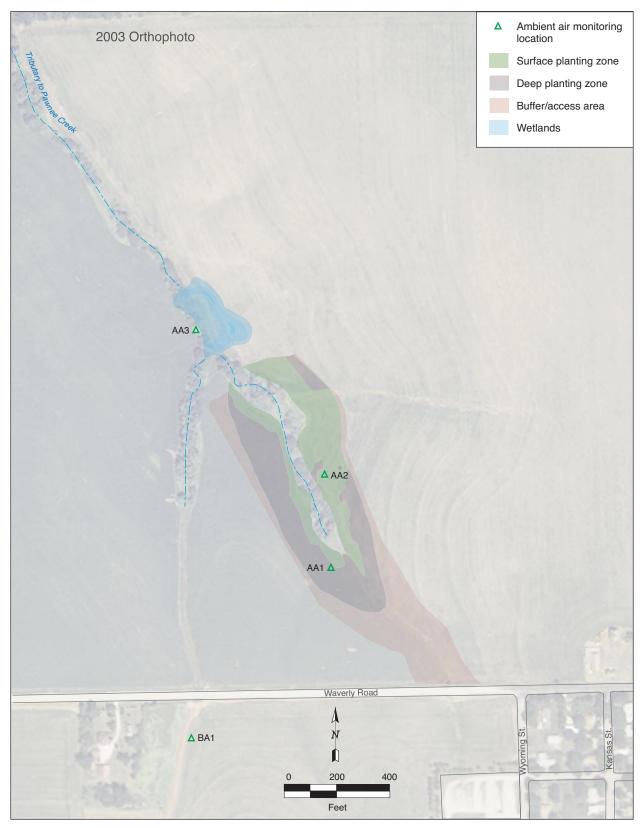


FIGURE 3.6 Locations proposed for the periodic sampling of ambient air for volatile organic analyses during the initial (five-year) monitoring period. Source of photograph: NAIP (2003).

4 References

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Appendix A:

Well Construction Information



FIGURE A.1 Locations of all permanent groundwater observation points at Murdock. Source of photograph: NAIP (2003).

TABLE A.1 Construction data for permanent observation points at Murdock, Nebraska.

	Screen Interval Depth	Well Depth		Screen Interval Depth	Well Depth
Location	(ft BGL)	(ft BGL)	Location	(ft BGL)	(ft BGL)
1S	30–40	40	SB69D	62.2–72.2	72.2
1D	85–95	95	SB70S	50.8-58.3	58.3
2S	70.5-80.5	80.5	SB70M	58.4-68.4	68.4
2D	85–95	95	SB71S	53.1-60.6	60.6
3S	64–74	74	SB71M	60.7-70.7	70.7
3D	80–90	90	SB71D	70–80	80
4S	30-40	40	SB72S	49-56.5	56.5
4D	80–90	90	SB72M	59.7-69.7	69.7
MW6	78–83	83	SB72D	70–80	80
WP49 ^a	67–76	76	PMW1S	4.6-14.6	15
WP51D ^a	73–76	76	PMW1D	24.6-34.6	35
WP54 ^a	50–59	59	PMW2SA	4.6-14.6	15
TEST-1	51–81	91	PMW2SB	4.6-14.6	15
GWEX-1	47–77	82	PMW2D	19.6–29.6	30
SB63S	23–38	42	PMW3S	4.5-14.5	15
SB63D	36.5–51.5	53.5	PMW3D	19.5–24.5	25
SB64S	30–50	53	PMW4	19.5–24.5	25
SB64M	48.5-68.5	71.5	PMW5	4.5–14.5	15
SB64D	67–87	89	PMW6	4.5–14.5	15
SB65S	23.7–38.7	40.8	PMW7	14.5–19.5	20
SB65D	38–53	55	PMW8	4.5-14.5	15
SB68S	49–56.5	56.5	PMW9S	5–9	9
SB68M	57.2-67.2	67.2	PMW9M	11–15	15
SB68D	67.8–77.8	77.8	PMW9D	19.5–29.5	32
SB69M	51.9-61.9	61.9			

^a Critical temporary piezometer for water level monitoring; permission to retain this piezometer is being requested.

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STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES

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	\top		Dana	3,11,0,1			10.20	- 11 10 10 10 10 10 10 10 10 10 10 10 10			
	2012/2015					الراس الأليب				Section of Section	
2. (Geologi	c Materia	ls Logg	ged							
De	pth in F	eet				1	Dep	th in Feet			
From		To		Descript			From	To		Description	
- 0		5		h brown silty clay		_ _					
5 11		11		n/gray silty clay w		- -					
13		15	tan/or	n/gray silty fine sa ray fine sand w	ith silt and clay	,					
			5.		(Additional		any be	auhmitted)			
Contract of	100 100 - 100 - 100		4 A. C.	MATERIAL STREET	(Additiona	i silects ii	lay oc	sublinitied)	and the second second		The second second
2 Y om	familia	- with the	inform	ention submitted o	n this registration	and to th	o heat	of my knowledg	e it is true		
J. I am	Tattitila	with me	mionn	ацон ѕидинией (m uns registration	i, and to th	ie nest	or my knowiedg	CILIS UUC.		
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777	otor Wi-		170	ionatura	-127/0	/ S		W-11 O	ania Cicarto		Date
W	ater We	п сорци	CIOT'S S	ignature	Date	×	if		ner's Signature inknown or Dec	ceased	Date

Form provided by Forms-On-A-Disk · (214) 340-9429 · FormsOnADisk.com

Mail to: DNR PO Box 94676 Lincoln, NE 68509-4676 Phone: (402) 471-2363

January 2004 DNR Form 145

STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES WATER WELL REGISTRATION

	FOR DEPARTMENT USE ONLY
Re Ov	gistration Date Sequence No. Registration No. NRD
. a. b. c.	Well Owner's First Name - Last Name Company Name USDA CEPD FSA/CCC Correspondent Name - Attention Steve Gilmore Address 1400 Independence Avenue, SW City Washington State DC Zip 20250-0513 Telephone 202.720.5104
. a. b.	Contractor's License No 89019 Contractor's Name Dennis J. Anderson Contractor's Brail Address danderson@thielegeotech.com
a. b. c. d. e. f. g.	Well location: SE 1/4 of the SW 1/4 of Section 10 , Township 11 North, Range 10E East/West, Cass County. Natural Resources District Lower Platte South The well is 361 feet from the (North/ South) section line and 2064 feet from the (East/ West) section line. or Latitude Degree 40 Minute 17 Second 9.48 Street address and subdivision, if applicable — Block — Location of water use, if applicable (give legal descriptions) — If for irrigation, the land to be irrigated is — acres. Well reference letter(s), if applicable: PMW-ID HHSS PWSID
Ma Geo Mu	mits None Surface Water Permit Number Industrial Permit Number Industrial Permit Number Othermal Permit Number Transfer Out-of-State Permit Number Conduct Permit Number Il Spacing Permit Number Other Permit Number SSS NDEQ
Pur	pose of well (indicate one):AquacultureCommercial/IndustrialDewatering (over 90 days) DomesticGround Heat ExchangerGroundwater Source Heat PumpIrrigationInjection LivestockXMonitoringObservationPublic Water Supply (with spacing (46-628)) Public Water Supply (without spacing)RecoveryOther(indicate use)
a. Is b. It	Ils in a Series. s this well a part of a series? X Yes; go to part b of this section. No; go to part 7 of this application f one or more of the wells in the series is currently registered, give the well registration number low many wells in the series are you registering at this time? 15
a. Is b. R c. R e. O	lacement and abandoned well information. this well a replacement well? Yes X No egistration number of abandoned well If not registered, date abandoned well was constructed: (mm/dd/yy) eplacement well is feet from abandoned well. d. Abandoned well last operated (mm/dd/yy) riginal well pump column size: inches f. Completion of original well abandonment on (mm/dd/yy) ocation of water use of abandoned well:

					-			20 to 10 to 10	PMW-	10 (ant.
	nformation			1000 to 1000 t	ota se	72		100 100	300 miles	
			s time? Yes							
			wner in section 13				imp installed by	contractor in secti	on 2? Yes	No.
			installer, please fi							
			e No							
			Address							
	ump Installer's							-	-	
Pi	ump installer's	Firm A	Address			~.				
						Zip.		Telephone		
	•		imail Address							
			gallons per i	ninute	_ Measure	ed _	Estim			
			inches					· · · · · · · · · · · · · · · · · · ·	feet	
f. Pt	umping equipm	nent ins	talled (mm/dd/yy) _ nd constructed to p	1 41 56			p Brand		*	
n. 11	nis well is desi	gned an	a constructed to p	oump less than 50) gpm2	Yes	No			
9. Well Co	onstruction Inf	ormatio	n.			9				100
a. Tot	tal well depth:	35		feet. b	. Static w	ater le	vel:	feet.	-	
c. Pur	mping water le	vel:		feet. d	l. Well Co	onstruc	tion began (mm/dd	(yy) 04/29/05		
e. We	ll Construction	compl	eted: (mm/dd/yy) 04	/29/05 f.	Bore ho	le diam	eter in inches	Top 8	Bottor	n 8
g. Cas	sing and Scree	n Joints	are Welded	Glu	ed	5	Threaded X	Other		
									(Alexandra) School and and	and the second of the second
10. W	ell Construction	on (Casi	ing & Screen)- c,	d, e, & g measure c	ments sho		in inches to three	decimal places f		i h
Pla	acement Depth		Casing or	Inside	Outs		Wall	Screen Slot	Type of	Trade Name
1200000	in Feet		Screen	Diameter	Diam	eter	Thickness	Size	Material	
From	To									
0	24.6		Casing	2.00	2.375		0.1875	N/A	PVC	EMI
24.6	34.6		Screen	2.00	2.375		0.1875	0.010	PVC	EMI
		-	 						 =.	
		official residence		1	L. THOUSE					
11. Gr	out and Grave						1			
Placement	Depth in Feet		Gr	out or				Material Des	scription	
From	To			el Pack					ar i	
21.75	35		onite Seal		-		Ben Environp Washed Silic	lug Bentonite (Chips	
41.75	33	Заци/	Gravel Pack		- 1	10/20	washed Silic	а запи		
	J					1				
2. Ge	ologic Materia	ls Logg	red							
	h in Feet	20 20 26	,		1	Der	oth in Feet			
From	То		Descripti	on	ľ	From			Description	
0	5	orangis	h brown silty clay	with fine sand		15		ght tan silty fi		
_ 5	11	light ta	n/gray silty clay wi	th fine sand	_ _	30		rangish tan sil		
11	13		n/gray silty fine sar		_ _	35	38 o	rangish mudd	y, fine/medium	n sand
13	15	tan/gr	ay fine sand wi	th silt and clay	<u> </u>	-				
54				(Additiona	l sheets m	nay be	submitted)			
			and the state of t				10 15 10 10 10 10 10 10 10 10 10 10 10 10 10	ANTONIO ANTONIO A	Albert & Company	and a supplied that the
3. I am fa	umiliar with the	inform	nation submitted o	n this registration	n, and to th	e best	of my knowledge	e it is true.		
				19						
•	7.1	1	0	1/1						
	シーイ	Tak		8/24/0	5					
Wate	er Well Contra	ctor's S	ignature	Date		100		ner's Signature		Date
						if	Contractor is u	inknown or Dec	ceased	

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Reparty 2004 (SNR Farm HE)

STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES

P	hone: (402) 471-2363 WATER	WELL REGISTRATION
	FOR DEP	PARTMENT USE ONLY
	Registration Date Sequence 2 Owner Code No. Receipt No.	NoRegistration NoNRD
1.	a. Well Owner's Pirst Name — b. Company Name USDA CEPD FSA/CCC c. Correspondent Name — Address 1440 Independence Avenue, SW City State	Lot Name Attention Steve Gilmore Zip Telephone
2.	a. Contractor's License No. 89019 Contractor's Ernsil Address danderson@thicleger b. Drilling Firm Nams Thiele Geotech, Inc. Address 13478 Chandler Road City Omaha State Drilling Firm's Email Address www.thielegeotech	NE Zip 68138 Teleptione (492) 556-2171
	b. Natural Resources District Lower Platte South c. The well is 446 feet from the (**) North/60 South or Latitude Degree 40 Minute 55 Longitude Degree 96 Minute 17 d. Street address and subdivision, if applicable — Block — c. Location of water use, if applicable (give legal description of the imigation, the land to be irrigated is —	Second 47.34 Second 9.84 Let ages.
	g Well seference letter(s), if applicable: PMW-2SA Pormits None Management Area Permit Number Goothormal Permit Number Municipal Permit Number Well Specing Permit Number HHSS	Surface Water Permit Number Industrial Permit Number Transfer Out-of-State Permit Number Conduct Permit Number Other Permit Number NDBO
_		Commercial/Industrial Dewatering (over \$0 days) midwater Source Hoat Pump Irrigation Injection Conservation Public Water Supply (www.managements)
	Wells in a Series. a Is this well a part of a series? X Yes; go to part b of this. b. If one or more of the wells in the series is currently registered. How many wells in the series are you registering at this time?	sectionNo; go to part 7 of this application d, give the well registration number
	Replacement and shandoned well information. a. Is this well a replacement well?YesXNo b. Registration number of shandoned well. c. Replacement well is feet from abandoned well. b. Original well pump column size: inshes c. Location of water use of shandoned well:	If not registered, date abandoned well was constructed: practice) d. Abandoned well last operated package f. Completion of original well abandonment on (www.y)

	3152.		with the same of t					pnw	-25A (con
	np Information		WESTALL XX	and According					
			is time? Ye						
Tap	ump installed	by well o	owner in section 1	? Yes	No Is	pump installed by	contractor in sect	ion 27 Yes	No.
			installer, please f						
h.	Pump Installer	's Licen	sie No.	Po	ud punger, s				
			Address		46.0				
	Pump Installer								
- 23	Pump Installer	's Firm	Address			_	- X 1010 mm		
	City			State	2	ip	Telephone_		
			Ernail Address				a continue		
0,	Primping Rate	_	gallons per	minute		Estin			
d.	Drop pipe dise	neter _	inches		e. L	eagth of drop pipe		feet	
£ 1	Pumping equip	oment in	stalled (seese(g)		g P	amp Board			
h.	This well is de	signed a	nd constructed to	pump less than 50	gon X	resNo			
9. Well (Construction I	formation	on.	- 50					
a T	otal well depth	: 15		foot. t	Static water	lovel: -	feet.		
c P	umping water	level:	-	feet d	Well Const	ruction began remove	Port 04/28/05		
			deted: (message) B	Section 100			Top 8	Botter	n 8
		2000000	s are Welded	V-11000000		Threaded X	Other		
_				***************************************					
10.	Well Construct	ion (Cas			A	be in inches to thre	e decimal places	-	
- 6	lacement Dop	-	Casing or	Inside	Outside	Wall	Screen Stot	Type of	Trade Name
	in Fost		Screen	Diameter	Diameter	Thickness	Size	Motorial	2160027481160
From	To			FEB. SEC.	10000	100000000000000000000000000000000000000	100000	1000	100000
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4.6	14.6		Screen	2.00	2,375	0.1875	0.010	PVC	EMI
			-	_	_	_	-		
								1	
11. (Prout and Grav	el Dack			-				
	nt Depth in Fe		G	TOUT OF			Material De	poription	
From	To		Gra	vel Pack	1135.7		000000000000000000000000000000000000000		
- 0	2.6		onite Scal			WyoBen Environplug Bentonite Chips			
2.6	15	Sand	/Gravel Pack		19	20 Washed Silic	a Sand		
	landa eda Adestea	into Taxa							
	ieologio Mater	une Log	200		1	world for Want			
From	th in Feet To		Descript	tion		Repth in Feet m To		Description	
0	5	dark	brownish oran		1.0			Description	
5	15	Light to	saigray fine sand a	ed silt with clay					
100	515/85	- press	e postalis e de como	and the second					
				1		- 1			
				(Additional	shtets may	be submitted)			
_									
3. Ian:	familiar with t	he inform	nation submitted	on this registration	a, and to the be	st of my knowledg	e it is true.		
	-	10	1	-11					
	1):	IA	L	8/29/0	5				
Wa	ster Well Con	actor's	Signature	Date		. Well Ow	ner's Signature		Date
			- Constitution			if Contractor is		ceased	

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DMS Form 145

STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES

Phone: (402) 471-2363 WATER WELL REGISTRATION FOR DEPARTMENT USE ONLY Registration No. Registration Date Sequence No. Owner Code No. NRD Receipt No. Well Owner's First Name Last Namt -Company Name USDA CEPD FSA/CCC Attention Steve Gilmore c Correspondent Name --Address 1400 Independence Avenue, SW City Washington State DC Zip 20250-0513 Telephone 202.720.5104 89019 2. a. Contractor's License No. Contractor's Name Dennis J. Anderson danderson@thiclegeotech.com Contractor's Email Address b. Drilling Firm Name Thiele Geotech, Inc. Address 13478 Chandler Road State NE Zip 68138 City Omaha Telephone (402) 556-2171 Drilling Firm's Small Address www.thiologootech.com 3. a. Well location: SE Mof the SW Mof Section 10 , Township 11 North, Range 10E East/West, Cass b. Natural Resources District Lower Platte South a. The well is __433 __feet from the (□ North/□ South) section line and __2,047 __feet from the (□ East/□ West) section line. or Latitude Degree 40 Longitude Degree 96 Minute 55 Minute 17 Second 47.22 Second 9.66 Street address and subdivision, if applicable --Block - Location of water use, if applicable (give legal descriptions) f. If for irrigation, the land to be irrigated is g Weil seference letter(s), if applicable: PMW-2SB HHSS PWSID 4. Permits None Surface Water Permit Number Management Area Permit Number Industrial Permit Number Geothermal Permit Number Transfer Out-of-State Permit Number Conduct Permit Number Municipal Permit Number Well Spacing Permit Number Other Permit Number HHSS _ NDEQ _ 5. Purpose of well (indicate one): ____ Aquaculture ___ Commercial/Industrial Dewatering (over 90 days) Ground Heat Eachanger ____ Groundwater Source Heat Pump ___ Inigation Injection X Monitoring Observation Public Water Supply (see specing 146-500) Public Water Supply (vetoes mone) Wells in a Series. No; go to part 7 of this application a. Is this well a part of a series? X Yes, go to part b of this section. b. If one or more of the wells in the series is currently registered, give the well registration number _____ c. How many wells in the series are you registering at this time? 15 Replacement and abandoned well information. a. Is this well a replacement well? ____Yes _X No b. Registration number of abandoned well If not registered, date abandoned well was constructed: (www.po)___ c. Replacement well is feet from abandoned well. d. Abandoned well last operated (nactory) e. Original well pump column size: inches f. Completion of original well abandonment on (molecular) g. Location of water use of abandoned well:

a. 1s										286 (Cord
	Information									
		ed at this time?								
Is pur	np installed b	y well owner in se	sction 1?	Yes	No	ls po	emp installed by	ocutractor in sect	ion 27Yea	No.
		y pump installer, p								
p. 17	tub marries	's License No.		Pu	mp instal	er's tva	m.e			
Pi	imp installer	s Email Address							_	
		s Pirm Name	_							
	штр ильталит ity	e Firm Address		State	-	Tim		Tetenhone		-
		s Firm Email Add	hans	g-man	_	2.40		Teechnoise		
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d. Di	on nine diam	eterin	urbec						Seet	
		ment installed pass						-		
h 73	is well is de	igned and constru	cted to pun	up less than 50) apm	X Yes	No			
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	metruction Is		***							
	al well depth	-	fie				vel: -	foot.		
		evel:					tion began (m/s	VV		-
		m.completed: (was							Bottor	n 8
g. Cas	ing and Scre	a Joints are W	reided	Giu	ed	1.0	Threaded X	Other_		
10. W	ell Construct	on (Casing & Son	nen)- e d e	& e measure	emente sh	onld be	in inches to fore	decimal places		
-	à		2	Q.		1	e	f	X.	h
Pla	coment Dept			Inside		side	Wall	Screen Slot	Type of	Trade Name
0	in Feet	Sen	con.	Diameter	Dian	neter	Tatckness	Size	Material	
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4.6	14.6	Screen	-	.00	2.375		0.1875	0.010	PVC	EMI
-										100
Berlin B	OTHER DESIGNATION OF THE PERSON OF THE PERSO	/// HE HE WALLE	-	-	-	-	II - 35 - 111 - 35	************	-	COLUMN TERM
	cost and Grave	A CONTRACTOR OF THE PARTY OF TH	0			-		Mariella	1.00	
From	Depth in Fee	4	Gravel					Material Des	carpason	
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2.4	15	Sand/Gravel)	Pack.			19/20	Washed Silic	a Sand		
100				Sec. 11.		To III	COLINA COL			, MV4
				_	_					
2. Ge	ologie Mater	als Logged			67					
	in Feet	-			-		oth in Feet			
From			Description			From	To		Description	
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5										
			3 34 6	(Additions	I sheets a	nay be	submitted)			
			-				_		4 1 1 1 1 1 1 1 1	
5	miliar with t	e information solv	mitted on t		n and to t	he hest	of my knowledg	e it is true.		V/13%-26119.
5	miliar with th	e information sub	mitted on t		n, and to t	he best	of my knowledg	e it is true.		
5	miliar with th	e information sub	mitted on t		n, and to t	he best	of my knowledg	e it is true.		
5	miliar with ti	e information sub-	mitted on t		n, and to t	he best	of my knowledg	e it is true.		
5	miliar with ti	e information sub		his registration		he best	of my knowledg	e it is true.		iii
5	miliar with th	e Information sub				he best	of my knowledg	e it is true.		

Form provided by Forms-On-A-Dlak (214) 340-9423 - Forms-On-A-Dlak.com

STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES WATER WELL REGISTRATION

Phon	ie: (402) 471-2363	WATER V	WELL REGISTRATION
		FOR DEP	PARTMENT USE ONLY
10000	gistration Date wner Code No.	Sequence N Receipt No.	No. Registration No. NRD
ь. Б.		DA CEPD PSA/CCC	Last Name = Attention Steve Gilmore
, a.	Contractor's License No Contractor's Email Addi Drilling Firm Name Address 13478 Chan City Omaha Drilling Firm's Email Ad	ess danderson@thielegeo Phiele Geotech, Inc.	NE Zip 68138 Telepisons (492) 556-2171
a. b. c. d. e. f. g.	Natural Resources Distri The well is 489 or Latitude Degree 40 Longitude Degree 96 Street address and subdiv Block Location of water use, if If for irrigation, the land	t Lower Platte South feet from the (□ North/□ South Minute 55 Minute 17 ision, if applicable — applicable (give legal description)	Second 47.46 Second 9.84 Lot =
Ma Ge Mu We	mits None inagoment Area Pormit Nur othermal Permit Number inicipal Permit Number ell Spacing Permit Number ISS		Surface Water Permit Number
Per	pose of well (indicate one) Domestic Crown Livestick Public Water Supply (we	d Heat Exchanger Groun X Monitoring	Commercial/Industrial Dewatering (over 90 days) adwater Source Heat Pump Irrigation Injection Observation Public Water Supply (with appending pet 400) Other Ondoor and
a. I b. I	fone or more of the wells it	X Yes; go to part b of this s the series is currently registered, are you registering at this time?	d, give the well registration aucuber
a. b. 5 c. R c. C	elecement and abandoned we this well a replacement we legistration number of aban eplacement well is reginal well pump column : ocation of water use of aba	IP Yes X No Soned well Seet from abandoned well. Ize: Inches	If not registered, date abandened well was constructed: g-wwwyg d. Abandened well last operated (mwwy) f. Completion of briginal well abandenment on-junkelyst

							PMW.	-20 (Cont
	Information					500	See Alleller	25,000,000
		led at this time? Y						
ls pun	p installed	by well owner in section !	?Yes	No I	s pump installed by	contractor in sect	ion 27 Yes	No.
		by pump installer, please						+
		's License No.						
Pu	mp Installer	's Email Address	_					
		's Firm Name						
		's Firm Address						
Clt			State		<u>шр</u>	Telephone		_
	TANK MANAGEMENT	's Firm Email Address _						
		gallons per	mirrate					
		neterinches			ength of drop pipe		feet	
		ment installed (wavery)			ump Brand			
h. Th	is well is de	signed and constructed to	premp less than 5	0 gpm X	YesNo			
. Well Co	nstruction L			and who are the		7,45		
	d well depti	The Assessment Control of the Contro		 Static water 	r level:	foot.		
c. Pum	ping water	levti -	foot.	d. Well Cons	truction began (Port 04/28/05		5000
		on completed: (www.eye) _0			iameter in inches	Top 8	Botton	n 8
g. Casi	ing and Stre	en Joints are Welded	Glo	ed	Threaded X	Other		
0. We	II Constitute	fon (Casing & Screen)- c.	4 4 8	amanta di sala	he is inches to the	decimal along		
0	II CONSTAC	b	G C SE	d d	e e	f decuma posses	g	l h
Pia	cement Dep		Inside	Outside		Screen Slot	Type of	Trade Name
	in Feet	Screen	Dismeter	Diamete	Thickness	Size	Material	
ross	To 19.6	Carley	2.00	2,375	0.1076	57/4	PVC	EMI
9.6	29.6	Casing	2.00	2.375	0.1875	N/A 0.010	PVC	EMI
-		Del cea	100	21072	0.0075	1		0.0
				-			-	
	out and Gran		hout or			16 c 51 fb	100	
rom	Depth in Fe		evel Pack			Material De	scriptum	
0	17.6	Bentonite Seal	artin i desc	W	yoBen Environp	lug Bentonite	Chips	
17.6	30	Sand/Gravel Pack			720 Washed Silic	And in column 2 is not a second		
-				-	- Annual Contract	-		
Z. Geo	ologic Mate	ials Logged						
	in Freet				Depth In Feet			
From	To	Descrip		Fr	om To		Description	
5	5 20	dark brownish orac light tin/gray fine tand :						
26	30	fight tan/gray fine/media						
		The control of				7.100 0	As 20 - 20 - 20	1-50
			(Additions	d sheets may	be submitted)			
			p southout	- may	Name of the last o			-
I am fur	niliar with t	he information submitted	on this registration	n and to the h	est of my knowledg	e it is true		
		and the same of th	and to grant the same		and same			
196	_	.00						
- 1):	IHE.	8/24/	15				
Water	Well of	ractor's Signature	Date		Well Ow	ner's Signature		Date
25,000		o e constant	100,000		if Contractor is	No.	beesen	

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STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES

į	Phone: (402) 471-2363 WATER WELL R	EGISTRATION
	FOR DEPARTME	ENT USE ONLY
	Registration Date Sequence No. Owner Code No. Receipt No.	Registration NoNRD
1.	b. Company Name USDA CEPD FSA/CCC c. Correspondent Name	Last Name Attention Steve Gilmore Zip 20250-0513 Telephone 202.720.5104
2.	2. a. Contractor's License No 89019 Contractor's Email Address danderson@thielegeotech.com b. Drilling Firm Name Thiele Geotech, Inc. Address 13478 Chandler Road City Omaha State NE Drilling Firm's Email Address www.thielegeotech.com	Zip 68138 Telephone (402) 556-2171
3.	Longitude Degree 96 Minute 17 Sec d. Street address and subdivision, if applicable — Block — e. Location of water use, if applicable (give legal descriptions) —	
4.	4. Permits None Surfac Management Area Permit Number Indust Geothermal Permit Number Trans: Municipal Permit Number Condu Well Spacing Permit Number Other	ce Water Permit Number rial Permit Number fer Out-of-State Permit Number uct Permit Number Permit Number
5.	Domestic Ground Heat Exchanger Groundwater So Livestock X Monitoring O	al/Industrial Dewatering (over 90 days)
5.	 Wells in a Series. a. Is this well a part of a series? X Yes; go to part b of this section. b. If one or more of the wells in the series is currently registered, give the c. How many wells in the series are you registering at this time? 15 	
7.	c. Replacement well is feet from abandoned well.	egistered, date abandoned well was constructed: (mm/dd/yy) I. Abandoned well last operated (mm/dd/yy) Completion of original well abandonment on (mm/dd/yy)

A LONG THE RESERVE					This was the same		Living.	35 (Cont.)
	Information		0.00 PROPERTY					
n. Isy	pump installed	at this time??	Yes X No		4033 203443500			
Is pare	np installed by	well owner in section	1?Yes	_No	Is pump installed by	contractor in sect	on 27 Yes	No.
		pump installer, please						
b. Pu	mb Intaller, s	License No.	P	emp (nstalle	er's Name	545		
Pu	mp Installer's	Email Address						
Po	ump Installer's	Pinn Name						
		Pirm Address						
Cit					Zip	Telephone		
		Firm Email Address						_
o. Pui	mping Rate	gallons pe	et minute		sd Eatin			
		er inches			e. Length of drop pipe		fret	
£ Pu	mping equipm	cut installed (mystrat			g. Pump Brand	-		
h. 186	is well is desig	sted and constructed t	o promp less than o	u gpm/	YesNo			
Well Con	nstruction Info							
a. Tota	d well depth:	15	feet.	b Static w	ester level:	fixet		
			_ feet.	d. Well Co	onstruction began seve	9no 04/25/05		
					le diameter in inches		Botton	n 8
g. Cași	ing and Screen	Joints are Welded	Gh	ed	Threaded X	Other		
0. We	Il Construction	(Casino & Screen)	o. d. c. & w measur	ements sho	and be in inches to thre	e decimal places		
	a	à	C C	T d		f	E .	1 h
Plac	oement Depth	Casing or		1	ide Wall	Screen Slot	Type of	Trade Nume
	In Feet	Screen	Diameter	Dian	eter Thickness	Size	Material	
rom	4.5	Casing	2.00	2.375	0.1875	N/A	PVC	EMI
.5	14.5	Screen	2.00	2.375	0.1875	0.010	PVC	EMI
3	14.3	Beren	2.00	2,015	4.1473	0.000	-	E.V.
						_		1
							L	
						-		NAME OF TAXABLE PARTY.
	out and Gravel							-
(accment)	Depth in Feet	89	Grout or			Material De	ceiption	
Lacement l	Depth in Feet To	Gr	Grout or ravel Pack		WyoBen Kayiran			
(accment)	Depth in Feet To 2.4	89	ravel Pack		WyoBen Environ 10/20 Washed Sili	dug Bentonite		
tocement l rom 0	Depth in Feet To 2.4	G Bentonite Seal	ravel Pack			dug Bentonite		
lacement l com 0	Depth in Feet To 2.4	G Bentonite Seal	ravel Pack			dug Bentonite		
lacement l com 0 2.4	Depth in Feet To 2.4	G Bentonite Sead Sand/Gravel Pack	ravel Pack			dug Bentonite		
lacement l com 0 2.4	Depth in Feet To 2,4 15 ologic Materia in Feet	G Bentonite Seal Sand/Gravel Pack is Logged	ravel Pack		10/20 Washed Silis Depth in Feet	dug Bentonite	Chips	
0 2.4 . Geo Depth From	Depth in Feet To 2.4 15 blogic Materia in Feet To	Ga Bentonite Seal Sand/Gravel Pack is Logged	ption		10/20 Washed Silis	dug Bentonite		
0 2.4 1. Geo Depth From 0	Depth in Feet To 2.4 15 ologic Materia in Feet To 5	Gambonite Seal Sand/Gravel Pack togged Descri	ption		10/20 Washed Silis Depth in Feet	dug Bentonite	Chips	
tacement l rom 0 2.4 2. Geo Depth Foom 0 5	Depth in Feet To 2.4 15 15 ologic Material in Feet To 5 10	Gambonite Seal Sand/Gravel Pack to Logged Descrit dark gray silty clay dark brown silty c	ption		10/20 Washed Silis Depth in Feet	dug Bentonite	Chips	
tacement leading to the second of the second	Depth in Feet To 2.4 15 blogic Materia in Feet To 5 10 12.5	Gambonite Seal Sand/Gravel Pack togged Descri	ption y		10/20 Washed Silis Depth in Feet	dug Bentonite	Chips	
1 Ceon Depth From 0 5 10 10 10 10 10 10 10 10 10 10 10 10 10	Depth in Feet To 2.4 15 blogic Materia in Feet To 5 10 12.5	Gambonite Seal Sand/Gravel Pack togged Descrit dark gray silty clay dark brown silty clay	ption y lay	al sheets m	Depth in Feet From To	dug Bentonite	Chips	
2. Geo Depth From 0 5 10	Depth in Feet To 2.4 15 blogic Materia in Feet To 5 10 12.5	Gambonite Seal Sand/Gravel Pack togged Descrit dark gray silty clay dark brown silty clay	ption y lay	al sheets m	10/20 Washed Silis Depth in Feet	dug Bentonite	Chips	
1. Geoment 1 om 0 2.4 2.4 2.4 2.1 Geometric 1 om 1 o	Depth in Feet To 2.4 15 clogic Materia in Feet To 5 10 12.5 15	Gand/Gravel Pack Sand/Gravel Pack Logged Describer Gark gray silty clay dark brown silty clay tan fine/medium se	ption y lay (Addition		Depth in Feet From To	dug Bentonite (a Sand	Chips	
7 (Second 1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	Depth in Feet To 2.4 15 clogic Materia in Feet To 5 10 12.5 15	Gand/Gravel Pack Sand/Gravel Pack Logged Describer Gark gray silty clay dark brown silty clay tan fine/medium se	ption y lay (Addition		Depth in Feet From To	dug Bentonite (a Sand	Chips	
7 (Section 1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	Depth in Feet To 2.4 15 clogic Materia in Feet To 5 10 12.5 15	Gand/Gravel Pack Sand/Gravel Pack Logged Describer Gark gray silty clay dark brown silty clay tan fine/medium se	ption y lay (Addition		Depth in Feet From To	dug Bentonite (a Sand	Chips	
Placement 1 7 om 0 2.4 2. Geo Depth From 0 5.10 12.5	Depth in Feet To 2.4 15 clogic Materia in Feet To 5 10 12.5 15	Gand/Gravel Pack Sand/Gravel Pack Logged Describer Gark gray silty clay dark brown silty clay tan fine/medium se	ption y lay (Addition		Depth in Feet From To	dug Bentonite (a Sand	Chips	
1 (Section 1) (1) (Section 1)	Depth in Feet To 2.4 15 15 15 16 17 17 18 19 19 19 19 19 19 19	Gand/Gravel Pack Sand/Gravel Pack Logged Describer Gark gray silty clay dark brown silty clay tan fine/medium se	ption y lay (Addition		Depth in Feet From To	dug Bentonite (a Sand	Chips	
1 (Section 1) (1) (Section 1)	Depth in Feet To 2.4 15 15 15 16 17 17 18 19 19 19 19 19 19 19	Gand/Gravel Pack Sand/Gravel Pack Logged Describer Gark gray silty clay dark brown silty clay tan fine/medium se	ption y lay (Addition		Depth in Feet From To	dug Bentonite (a Sand	Chips	
7 Section 1 Prom 0 2.4 Section 2. Geo Depth From 0 12.5 Section 1.5 Section 1.	Depth in Feet 2.4 15 clogic Materia in Feet To 5 10 12.5 15	Gand/Gravel Pack Sand/Gravel Pack Logged Describer Gark gray silty clay dark brown silty clay tan fine/medium se	ption y lay (Addition		Depth in Feet From To nay be submitted) ie best of my knowleds	dug Bentonite (a Sand	Chips	Date

Form provided by Forms-On-A-Disk • [214] 345-9429 • Forms-On-A-Disk.com

STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES

Phon	e: (402) 471-2363	WATER WELL	REGISTRATION	
		FOR DEPARTM	MENT USE ONLY	
	gistration Date vner Code No. Reco	Sequence No.		Registration NoN
5 c	Well Owner's First Name — Company Name USDA CEPD For Correspondent Name — Address 1400 Independence Aver City Washington		Last Nume — Attention St Zip 20250-051	eve Gilmore 3 Telephone 202,720,5104
b.		erson@thielegeotech.c ch, Inc. State NE	Contractor's Name Decom.	Telephone (402) 556-2171
a b c d e r g	The well is 554 feet from the or Latitude Degree 40	#####################################	on line and	Range 10E Bast/West, Cass County feet from the (Bast/ West) section line. S PWSID
Ma Geo Mu We	mits None nagement Area Porinit Number othermal Permit Number nicipal Permit Number til Spaoing Permit Number	Sur Ind Tra Cor Oth	floor Water Permit Number ustrial Permit Number ander Out-of-State Permit Number duct Permit Number ser Permit Number EQ	ober
Pur	pose of well (indicate one):Aqui DomesticGround Heat Exchar LivestockX Public Water Supply (without species)		reial/Industrial Source Heat Pump Observation Other	Dewatering (over 90 days) IntigationInjection Public Water Supply (wat species (#6-det))
a. li b. li	lis in a Series. It this well a part of a series? X Yes; if one or more of the wells in the series is of the many wells in the series are you regis	currently registered, give t	Grant Land 1 (1977) - 1 (1977) - 1 (1977)	
n Is b. R c. R e. O	iscement and abandoned well information this well a replacement well? Yes egistration number of abandoned well eplacement well is feet from riginal well pump column size: contion of water use of chandoned well.	X No	d. Abandoned well h	loned well was constructed: (====================================

								73	Pnw	-3D (Conit.)
t. Pump	Information									(a) thin (a) (a)
a Is	pump instal	led at the	time! Ye	s X No						
ls pun	np installed	by well o	waer in section !	7 Yes	No	Ispo	mp installed by	contractor in sect	ion 29 Yes	No.
				IE out license nue						
				Pur						
Pe	amp Installer	's Emril	Address							
	imp Installer									
			uddress						100	
	ty			State		Zip.		Telephone		_
			Email Address					0000		
			gallons per	minute	Measure		Estim			
d. Dr	op pipe dian	ieter _	inches						fact	
f. Pu	giupe gaiqui	ment ins	stalied (muscry)				ip Brand			
h. Th	is well is de	a Dougla	of constructed to	pump less than 50	gpm 2	Yes	No			
	astruction Is				V-276-			0-8000	777	
					. Static w	rater le	vel:	fect.		
c. Pur	sping water i	evel		feet. d	Well Co	onstruc	tion began (www	99 04/25/05		
s. Wel	Constructi	on comp	letted: punktoye 0	€/26/05 €	Boreho	ie diam	eter in inches	Top 8	Bottoe	n 8
g. Cas	ing and Stre	en Joints	are Welded	Glu	ed		Threaded X	Other_		
0. W	Il Constant	ion (Cas	tra & Sements o	d, e, & g measure	ments obs	14 hr	in inches to these	decimal alares		
	a construct	sens femare	b b	t c, as g inciseire	l d		n sacres to the	Greater parces	1 6	l h
Pla	sement Dept	6	Casing or	Inside	Outs		Well	Screen Slot	Type of	Trade Nam
	in Fort		Screen	Diameter	Diam	eter	Thickness	Size	Material	
rom	To		Codes	14.66	2 227	_	0.1077	Service	PALIC	UNET
9.5	19.5		Casing	2.00	2.375		0.1875	N/A 0.010	PVC	EMI
7.5	24.3	-	ocreea	2.00	2,313		0.16/3	6000	ric	EOIL
			1							
-		_		-						
CANCELL AND A STREET	out and Grav									
	Depth in Per	틱		rout or				Material De	rengtion	
0	17.2	Bente	nite Seal	vel Pack		Www	Ben Environn	les Rentonite (Chine	
17.2	25	+	Gravel Pack			WyoBen Environping Bentonite Chips 10/20 Washed Silica Sand				
			ale wite and			200				
						-				
Geo	ologio Mater	iels Log	ged							
Depth	in Feet				10	Dep	sta in Feet			
From To Description				From To Description 17 25 gray silty clay with sand						
0	5	dark gray silty day			- -	17	25 g	ray silty clay v	with sand	
10	12.5	dark brown sitty clay								
12.5	12.5 gray silty clay 17 tan fine/medium sand				_					
Jane 1				(Additional	l abouto -	nou ha	submitted)			
		_		faminicar.	SHOWS E	му ов	эссинној			
				** ***				4.15		
1 cm 381	maner with t	ne antoca	renour anparaties o	on this registration	, and to th	ic oest	ec my knowledg	e it is true.		
									. 100	
		(g) (g)	20							
7	1.1	0		8//-	3)					
)-1/	100		0/04/05						V
Wate	r Well (Cont	nactor's 3	Signature	Date		if		er's Signature aknown or Do	ceased	Date

Form provided by Forms-On-A-Disk + (254) 340-9429 • FormsOnADisk.com

January 2004 DNR Form 145

STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES WATER WELL REGISTRATION

Phone: (4	102) 471-2363	WA	TER WELL REG	ISTRATION		
		FOR	DEPARTMEN'	USE ONLY		
- Carrier	ration Date	Seque Receipt No.	ence No.		Registration No.	NRD
b. Co c. Co A	Vell Owner's First Name Ompany Name USI Orrespondent Name ddress 1400 Indepetity Washington	DA CEPD FSA/CCC	State DC Z	Last Name Attention Sto	eve Gilmore Telephone 202.720.51	04
b. Dr Ac Ci	ddress 13478 Chancity Omaha	ess danderson@thi	State NE Z	ip 68138	nnis J. Anderson Telephone (402) 556-	2171
b. Na c. Th or Lo d. Str	atural Resources Distriction well is 728 or Latitude Degree 40 ongitude Degree 96 oreet address and subdiv	t Lower Platte South feet from the (North/ Minute 55	South) section lin	e and 1,762 50.16 13.32	tange 10E East/West, Ca	
e. Lo f. If	for irrigation, the land	applicable (give legal desc to be irrigated is f applicable: PMW-4	eriptions)acre	S.	S PWSID	
Geother Municip	ement Area Permit Nur rmal Permit Number pal Permit Number pacing Permit Number	nber	Industrial Transfer Conduct	Vater Permit Num Permit Number Out-of-State Perm Permit Number	nber	
Do		d Heat Exchanger X Monitori	ingObse	ce Heat Pump _	Public Water Supply (with spa	Injection
a. Is this b. If one	e or more of the wells is	Yes; go to part be an the series is currently regs are you registering at thi	gistered, give the wel		part 7 of this application	
a. Is this b. Regis c. Repla e. Origin	stration number of aban acement well is	ell? Yes X No doned well feet from abandoned size: inches	If not regis	bandoned well la	ioned well was constructed: (ast operated (mm/dd/yy) ginal well abandonment on (m	

							fmu	1-4 (Cont.
	np luformation							
		led at this time?Y						
Is p	omp installed	by well owner in section	17 Yes	No	is pump installed by a	contractor in sect	ion 27 Yes	No.
		oy gump installer, please						
0	Pump installer	's License No.	Pu	mp installer'	s Name			
	Pomp installer	's Email Address						
		's Firm Name						
	22.00	's Firm Address			787	77.1		
	City				Zip	Telephone		
		's Pirm Email Address						
		gallons per						
		neterinches			Longth of drop pipe		lbet	
L	Pumping equip	ment installed (massy) signed and constructed to	arran has then \$1	g.	Pump Brand			
a.	rais were as net	afform the constructed to	pump sess coan 31	gpm _A	165	2002.0		
). Wall (Construction In		W000	5e/4040401904		CIV/05		
a. T	otal well depth	25	feet.	. Static wat	er lovel: -	fort.		
c. Pi	umping water l	evel:	fact. c	. Well Con	struction began (make	hai 64/26/05		-
e. W	ell Construction	on completed: (mass)	14/26/05 1	Hore hole	diameter in inches	Top 8	Botter	n 8
g. C	using and Scre	en Joiats are Welded	Glu	ed	Thresded X	Other		
0. 1	Well Construct	ion (Casing & Screen)- c	d a b a marrie	annes about	d he in inches to fire	decimal class		
	a.	b	O C	d	e or in merce to pare	I f	T 6	T h
P	lacement Dept	h Casing or	Inside	Outside		Screen Slot	Type of	Trade Name
	in Post	Screen	Dismeter	Diamete	r Thickness	Sizes	Material	100
rom	To 19.5	Carlos	2.00	2 300	0.1825	3714	PVC	EMI
9.5	24.5	Casing	2.00	2.375	0.1875	N/A 0.010	PVC	EMI
	2412	- DATECH	2.00	40.0	0.1015	0.010	1.0	-
								7
-	-		-		-	-		CONTRACTOR OF THE PARTY OF
	irout and Orav							
room.	To To	600	irout or evel Pack			Material Des	scription	
0	17.5	Bentonite Scal	ayet r ass.	V	VyoBen Environp	bus Bentonite	Chios	
17.5	25	Sand/Gravel Pack			0/20 Washed Silic			
	17.							
							-	
2. 0	leologic Mater	ials Logged						
Dep	th in Feet			1	Depth in Feet			
From		Descrip		P	rom To		Description	
5	13	dark brown silty ch						
13	20	tan/brown silty san tan/brown silty clay		-				
20	25	tan silt and sand	Treatment of the latest of the	- -				
	The same of	and the same of th	(Addition)	Laborate man	y be submitted)			
			Q Multivisio	. zacoto miaj	, ar minimum (
Land	Semiliar with the	e information submitted	on this resistantion	e and to the	heat of my knowledge	e it is tone		
or a summer	DESCRIPTION WHAT SE	to minormanou anomono	OII IIII INGIANIA	50, 200M, EC MAIL	ocas on my Knowneng			
			50					
888	250		12					
	1).	101.	8/20/no					
- 10	to While Cold	/ Similar	72705	16	W/- 13 /2-13	and Discourse		Date
16.2	Nei Mell Cabe	scioc's Signature	, Date		if Contractor is t	ner's Signature inknown or De	pessed	Date

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Mail to: DNR PO Box 94676 Lincoln, NE 68509-4676 Phone: (402) 471-2363

January 2004 Tells Name 141

STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES WATER WELL REGISTRATION

	FOR DEPARTMENT USE ONLY
	Registration Date Sequence No. Registration No. Owner Code No. Receipt No. NRD
	E. Well Owner's First Name Lest Name D. Company Name USDA CEPD FSA/CCC Correspondent Name Attention Steve Gilmore Address 1400 Independence Avenue, SW City Washington State DC Zip 20250-0513 Telephone 202.720.5104
1	a. Contractor's License No 89619 Contractor's Name Dennis J. Anderson Contractor's Email Address danderson@thielegeotech.com Drilling Firm Name Thiele Geotech, Inc. Address 13478 Chandler Road City Omaha See NE Zip 68138 Telephone (402) 556-2171 Drilling Firm's Email Address www.thielegeotech.com
	Natural Resources District Lower Platte South The well is 748 feet from the (CI North/Ed South) section line and 1,847 feet from the (CI Hart/Ed West) section line. or Latitude Degree 49 Minute 55 Second 50,34 Longitude Degree 96 Minute 17 Second 12.24 Street address and subdivision, if applicable — Block — Lot — Location of scater use, if applicable (give legal descriptions) — If for irrigation, the land to be irrigated is — acres
2	Permits None Surface Water Permit Number Industrial Permit Number Jeothermal Number Jeotherma
94	tupose of well (indicate one): Aqueoutture Commercial/Indestrial Dewatering (over 90 days) Domestic Ground Heat Eachanger Groundwater Source Heat Premp Irrigation Injection Livestrock X Monitoring Observation Public Water Supply (with quarter) (46-60%) Public Water Supply (without gards) Recovery Other
a. b.	Valls in a Series. Is this well a part of a series? X Yes, go to part b of this section. No; go to part 7 of this application. Hone or more of the wells in the series is currently registered, give the well registration number — How many wells in the series are you registering at this time? 15
L b. c. e.	eplacement and abendoaed well information. Is this well a replacement well? Yes X No Registration number of abandoned well If not registered, date abandoned well was constructed: Replacement well is feet from abandoned well. d. Abandoned well last operated (movely) Original well pump column size: taches f. Completion of original well abandonment on one-were Location of water use of abandoned well:

									pma	-5 (Cont.)
8. Pum	p Information			5 50005						
a. I	s pump install	ed at this	time?Ye	x No						
				7 Yes			unp installed by o	contractor in secti	on 27 Yes	No.
				fill out license our						
				Pu						
E	'ump installer	's Email A	Address							
8	ump lastalier	's Firm N	bette							
P	ump Installer	s Firm A	drhoss					-0.00		
	City			State		Zip		Telephone		0.35
	ump Installer									
				minute	Measure	ed.	Estim	ated.		
	Prop pipe dian					c. Len	gth of drop pipe		first	
	umping equip					g Pun	p Brand			
h T	This well is des	signed and	constructed to	pump less than 5	gpm 2	X Yes	No			
9. Well C	Construction In	formation				_	10 0			
A To	tal well depth	15		fect. 1	Static v	vater le	vel: -	feet.		
	imping water I	-					tion began o-wee	Commence of the second		
			and purely 0				gter in inches	Top 8	Botton	n 8
			ers Weided	17500			Threaded X	Other	- 0000	
	and and	a round				-	-			
10. W	Vell Construct	ion (Castr		d, e, & g measure			in inches to three	decimal places		
pi.	a Iscement Dept		Casing or	- Enside	Outs	_	Wall	Screen Slot	Type of	Trade Name
	in Feet		Screen	Diameter	Diam		Thickness	Size	Material	Trave Ivalie
From	To	- 1								
0	4.5		Casing	2.00	2,375		0.1875	N/A	PVC	EMI
4.5	14.5		Screen	2.00	2.375		0.1875	0.010	PVC	EMI
5.60			Lice		-	_				1
II. G	rout and Grav	al Basis		The state of the s				-		The second second
	Depth to Fee	-	G	rout or				Material Des	ceirtion	
From	To		One	wel Pack		100000	2007-00-200			
0	2.5		nite Seal	1000			Ben Environp		Chips	
2.5	15	Sand	Gravel Pack			10/20	Washed Silic	a Sand		_
		_	-						The state of	-
	1 - 11					_				
	cologic Materi	ale Logge	MI .			10000	A 10 Mars			
From	th in Feet To		Descript	tion	91.5	From	of in Feet To		Description	
0	5	dark b	rown silty cla			rrom	1.0		Description	
				dium sand with						
5	10	silt and								
10	15	tas fine/	medium sand wit	th silt and clay						
					_ 1 _			- 32		- 1
				(Additiona	sheets n	ay be	submitted)			
_		_						_		
3. 1 am f	amiliar with th	e informe	tion submitted o	on this registratio	n, and to ti	se best	of my knowledge	it is true.		
-	. 17	1 1								
- 1	1:1/-	tel		8/29/0	5					
Wat	ter Well Contr	actor's Sig	gnature	Date	-	-	Well Own	er's Signature		Date
				-		if	Contractor is a	THE PROPERTY OF THE PARTY OF TH	ceased	4,100,000,000

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g. Location of water use of abandoned well:

Mail to: DNR PO Box 94676 Lincoln, NE 68509-4676 January 2004 DNR Form 145

STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES

Phone: (402) 471-2363 WATER WELL REGISTRATION FOR DEPARTMENT USE ONLY Registration Date Sequence No. Registration No. Owner Code No. NRD Receipt No. Well Owner's First Name Last Name -b. Company Name USDA CEPD FSA/CCC Correspondent Name --Attention Steve Gilmore Address 1400 Independence Avenue, SW City Washington State DC Zip 20250-0513 Telephone 202.720.5104 Contractor's License No Contractor's Name Dennis J. Anderson Contractor's Email Address danderson@thielegeotech.com Drilling Firm Name Thiele Geotech, Inc. Address 13478 Chandler Road Telephone (402) 556-2171 City Omaha State NE 68138 Drilling Firm's Email Address www.thielegeotech.com Well location: SE 1/4 of the SW 1/4 of Section 10 , Township 11 North, Range 10 East/West, Cass b. Natural Resources District Lower Platte South c. The well is _____846 ___ feet from the (□ North/☑ South) section line and ____2,024 __ feet from the (□ East/☑ West) section line. _ Minute 55 or Latitude Degree 40 Second Longitude Degree 96 Minute 17 Second Street address and subdivision, if applicable _--Location of water use, if applicable (give legal descriptions) _--If for irrigation, the land to be irrigated is ____ Well reference letter(s), if applicable: PMW-6 HHSS PWSID Permits None Surface Water Permit Number Management Area Permit Number Industrial Permit Number Geothermal Permit Number Transfer Out-of-State Permit Number Municipal Permit Number Conduct Permit Number Well Spacing Permit Number Other Permit Number HHSS NDEQ Purpose of well (indicate one): Aquaculture Commercial/Industrial Dewatering (over 90 days) Ground Heat Exchanger Groundwater Source Heat Pump Irrigation X Monitoring Observation Public Water Supply (with spacing (46-638)) Public Water Supply (without spacing) Recovery Other Wells in a Series. a. Is this well a part of a series? X Yes; go to part b of this section. No; go to part 7 of this application b. If one or more of the wells in the series is currently registered, give the well registration number ___ c. How many wells in the series are you registering at this time? 15 Replacement and abandoned well information. a. Is this well a replacement well? Yes b. Registration number of abandoned well If not registered, date abandoned well was constructed: (mm/dd/yy) d. Abandoned well last operated (mm/dd/yy) c. Replacement well is feet from abandoned well. f. Completion of original well abandonment on (mm/dd/yy) e. Original well pump column size:

									Frence	1-6 (Cord
. Pump I			-20 cd	W-	1,527	1994		1877		
		ed at this time?								
Is pump	installed i	ry well owner in sect	ion 1?	Yes	No	ls pum	ip installed by	contractor in sect	ion 27Yes	Na.
		y pump installer, ple								
b. Port	ip installer	's License No.		- Ρμ	np Installer	r's Nam				
		s Brissil Address _	-	_		_				
		's Firm Name								
		's Firm Address		-		761				
City				Sime		2ф		Telephone		
		's Firm Email Addres gallone		_	Market	-	Table			
		setur inch						MISS		
E Trees	o pripe unan	ment installed power					Boand	-	1001	
h This	well is de-	rigned and constructs	of to mimo its	s firm 50	rom X	Vrs.	No			_
- (111)	Victoria in dec	One are conserved	a to pany too	A served 1/4	4	100				
Wall Cons	struction (o	formation.								
a. Total	well depth	15	feet,				d:	-		
	-	tvel	foct,		Well Co	eatructio	on began tom/st	90 04/25/05		
		on completed: practary					or in inches	Top 8	Bottor	n 8
g. Casin	g and Scree	on Joints are Wel	ded	Ghie	d	Th	weaded X	Other_		
. Well	Construct	ion (Casing & Screen			manta char	old he in	inches to thee	Angles of Alaban		-
v. wen	B	Ott (Custing or account	19-0, 0, 0, 0, 00 8		d d		e .	· f	T .	T h
Place	ment Dept	h Casing	or In	side	Outsi	de	Wall	Screen Slot	Type of	Trade Name
								Sign	Material	
	in Feet	Screen	n Dan	meter	Diame	oter	Thickness	9159	Monthle	
	To	3350	048 0270	meter	110000		Contracts.	2.5	200	TOUT.
TOMO .	To 4,5	Casing	2.00	meter	2.575	0	0.1875	N/A	PVC	EMI
rom	To	3350	048 0270	meler	110000	0	Contracts.	2.5	200	EMI EMI
roup 5	To 4,5	Casing	2.00	meter	2.575	0	0.1875	N/A	PVC	THE RESERVE OF THE PERSON NAMED IN
TOED	To 4,5	Casing	2.00	meter	2.575	0	0.1875	N/A	PVC	THE RESERVE OF THE PERSON NAMED IN
5 Orou	4.5 14.5	Casing Screen	2.00	meter	2.575	0	0.1875	N/A 0.010	PVC PVC	THE RESERVE OF THE PERSON NAMED IN
5 Grou	14.5 14.5 at and Grave	Casing Screen	2.00 2.00 Grout or	meter	2.575	0	0.1875	N/A	PVC PVC	THE RESERVE OF THE PERSON NAMED IN
5 Grou	4.5 14.5	Casing Screen	2.00	meter	2.375	0	0.1875 0.1875	N/A 0.010 Material De	PVC PVC	THE RESERVE OF THE PERSON NAMED IN
5 Georgia	14.5 14.5 at and Oray opts in Pee	Cusing Screen	2.00 2.00 Grout or Gravel Pack	meter	2.375	WyoB	0.1875 0.1875	N/A 0.010 Material De- log Bentonite	PVC PVC	THE RESERVE OF THE PERSON NAMED IN
5 Section 1 Occur	14.5 14.5 14.5 1 and Grave epth in Pee	Cusing Screen of Pack t Bentonite Seal	2.00 2.00 Grout or Gravel Pack	neter	2.375	WyoB	0.1875 0.1875 en Environp	N/A 0.010 Material De- log Bentonite	PVC PVC	THE RESERVE OF THE PERSON NAMED IN
Occupacement D	14.5 14.5 14.5 1 and Grave epth in Pee	Cusing Screen of Pack t Bentonite Seal	2.00 2.00 Grout or Gravel Pack	ng ler	2.375	WyoB	0.1875 0.1875 en Environp	N/A 0.010 Material De- log Bentonite	PVC PVC	THE RESERVE OF THE PERSON NAMED IN
Orough	To 4.5 14.5 14.5 st and Grave epth in Fee To 2.5 1.5	Cusing Screen of Pack t Bentonite Seal	2.00 2.00 Grout or Gravel Pack	ngeler	2.375	WyoB	0.1875 0.1875 en Environp	N/A 0.010 Material De- log Bentonite	PVC PVC	THE RESERVE OF THE PERSON NAMED IN
Orono acommon D orono 1 0 2.5	t and Grave epit in Feer 2.5 15	Casing Screen Screen of Pack t Bentonite Seal Sand/Gravel Pa	2.00 2.00 Grost or Gravel Pack	me for	2.575	WyoB 19/20 V	0.1875 0.1875 en Environp Washed Silic	N/A 0.010 Material De- log Bentonite	PVC PVC scription Chips	THE RESERVE OF THE PERSON NAMED IN
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Group From	To 4.5 14.5 14.5 14.5 15 and Grave optic in Feer To 2.5 15 15 15	Casing Serven Pack Bentonite Seal Sand/Gravel Pa ials Logged Dec	2.00 2.00 2.00 Grout or Gravel Pack ck		2.575	WyoB 19/20 V	0.1875 0.1875 en Environp Washed Silic	N/A 0.010 Material De- log Bentonite	PVC PVC scription Chips	THE RESERVE OF THE PERSON NAMED IN
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Group Gr	To 4.5 14.5 14.5 14.5 14.5 15 15 15 15 15 15	Casing Serven Pack Bentonite Seal Sand/Gravel Pa ials Logged Dec dark grayish be- brown silty day	2.00 2.00 2.00 Grout or Gravel Pack ck soription own silty cla	ay Aditional	2.375 2.375	WyoB 10/20 V Depth From	o.1875 1.1875 en Environp Washed Silic in Feet To uhmitted)	N/A 0.010 Material De- log Bentonite	PVC PVC scription Chips	THE RESERVE OF THE PERSON NAMED IN
Geodo Depth a From 0 12.5	To 4.5 14.5 14.5 14.5 14.5 15 15 15 15 15 15	Casing Serven Pack Bentonite Seal Sand/Gravel Pa ials Logged Dec dark grayish be- brown silty day	2.00 2.00 2.00 Grout or Gravel Pack ck soription own silty cla	ay Aditional	2.375 2.375	WyoB 10/20 V Depth From	o.1875 1.1875 en Environp Washed Silic in Feet To uhmitted)	N/A 0.010 Material De- log Bentonite	PVC PVC scription Chips	THE RESERVE OF THE PERSON NAMED IN
Geodo Depth a From 0 12.5	To 4.5 14.5 14.5 14.5 14.5 15 15 15 15 15 15	Casing Serven Pack Bentonite Seal Sand/Gravel Pa ials Logged Dec dark grayish be- brown silty day	2.00 2.00 2.00 Grout or Gravel Pack ck soription own silty cla	ay Aditional	2.375 2.375	WyoB 10/20 V Depth From	o.1875 1.1875 en Environp Washed Silic in Feet To uhmitted)	N/A 0.010 Material De- log Bentonite	PVC PVC scription Chips	THE RESERVE OF THE PERSON NAMED IN

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Mail to: DNR PO Box 94676 Lincoln, NE 68509-4676

January 2004 1000: Person 140

STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES WATER WELL REGISTRATION

Pho	ne: (402) 471-2363	WATER W	ELL REGISTRATIO	N	
		FOR DEPA	RTMENT USE ON	LY	
	egistration Date	Sequence No Receipt No		Registration No.	NRD
a a c	Company Name USDA C			Steve Gilmore	
b	Contractor's License No 1 Contractor's Email Address Drilling Firm Name Thiele Address 13478 Chandler F City Omaha Drilling Firm's Email Address	load State Ni	.ch.com Е Zp 6813	Dennis J. Anderson 8 Telephone (402) 556-2171	
a b c	Natural Resources District Lo	wer Platte South from the (North/2 South) Minute 55 Minute 17	Second 2,30 Second 51.3 Second 8.88	h, Range 16E East/West, Cass 5 feet from the (East/E West)	
c. £	Location of water use, if applies If for irrigation, the land to be it Well reference letter(s), if appli	riguted is	acres.	HSS PWSID	
Mi Mi WY	emits None imagement Area Permit Number cothermal Permit Number unicipal Permit Number ell Spacing Permit Number		Surface Water Permit N Industrial Permit Numb Transfer Out-of-State F Conduct Permit Number Other Permit Number NDEQ	eer Permit Number er	
Per		Exchanger Groundy Monitoring	neneroia/Industrial water Source Heat Pump Observation Other	Public Water Supply (was speciag (4)	tion
a. 1 b. 1	ells in a Sories. Is this well a part of a series? X If one or more of the wells in the series are y	ries is currently registered, gi	ive the well registration	o to part 7 of this application	
a. 1 b. F c. R e. C	placement and abandoned well info is this well a replacement well? Registration number of abandoned Asplacement well is	Yes X No well set from abandoned well. inches	d. Abendoned we	andoned well was constructed: however il lust operated moneye original well abandonment on powersy	

								Pmu	0-7 (cord.
	Information							105740	
		ed at this time?							
Is pur	mp installed	ly well owner in sec	tion 17 Yes	No	Is po	ump installed by	contractor in sect	tion 2? Yes	No.
		y pump installer, pl							
b. Pi	ump installer	s License No.		Pump Insta	iller's Ni	me			
		's Email Address			_	-			
		's Firm Name			-				
Pi	ump installer	's Firm Address		Berte	700		W. L. 10		
	ity	- TS - T - 1 4 4 4		state	_ Zib		Telephose_		
		s Firm Email Addre							
		gallor						2.1	
		neterinc			e. Lon	Rur or mob hrbs		Itel	
		righed and construct		on SD orem	y Ve	ip srma			
	101112	Agric are commune	no to pump ress an	an se Stee	A 160				
Well Co	matruction in	formation.					1700000		
		20				vel: _cs			
c. Pur	nging water	ovel:	feet.			tion began pow	Pro 05/25/05		
g. Wo	Il Constructi	on completed: passes	99 05/25/05	f. Bore l	lole dian	eter in inches	Top 8	Bottor	n 8
g. Cas	ing and Scre	en Joints are - We	lded	Gleed		Threaded X	Other_		
10. W	all Construct	ion (Casing & Scree	a) a d a B ama			to the book of the	designative trans		
su. w	B B	b b	any c, d, c, ac g mo.		d d	in makes to dare	6 decemai places	1 8	h
Piz	coment Dept				tside	Wall	Screen Slot	Type of	Trade Name
	in Feet	Seres	n Diamete	tr Dia	meter	Thickness	Size	Material	
Frum	14.5	Coston	2.00	2.375		0.1075	N/A	1999.00	nasr.
14.5	19.5	Casing	2.00	2.375		0.1875	N/A 0.010	PVC PVC	EMI
	77.0	50,000	2.00	2.070		0.1015	0.010	1.0	EU/EX
						1			11 11
-		-	-		-				
	out and Grav		-		-				
Prom.	Depth in Fer	C .	Grout or Gravel Pack		1		Material Do	scription	
0	12.5	Bentonite Seal	Ciaret I sta		Wyo	Ben Environm	log Bentonite	Chins	The book
12.5	20	Sand/Gravel Pa	ack.		10/20	Washed Silic	a Sand	- and a	
									(4)
							-		
2. Ge	ologic Mater	als Logged		- 86					
	in Feet		Contract Contract			th is Feet			
From 0	To 10	dark brown silty	scription		From	To		Description	
10	15		ay with fine san		-				
15	20		ay and fine sand			Valence			
	- 53777								
			(Additi	ional sheets	may be	submitted)			
				1000000	-	-		-	-
3. 1 am fa	million with th	e information subm	itted on this registr	stion, and to	the best	of my knowledg	e it is true.		
			L.						
-		- 1		1					
- 1	1:14	1.6.	8/24	as					
Wate	Well From	actor's Signature	Da	de .		Well Own	ner's Signature		Date
	10.4				15		inknown or De	ceased	

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Mail to: DNR PO Box 94676 Lincoln, NE 68509-4676 Phone: (402) 471-2363

January 2004 DNR Form 145

STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES

WATER WELL REGISTRATION

1 1101	EOR DEPARTMENT USE ONLY
P. Const.	FOR DEPARTMENT USE ONLY
Re	gistration Date Sequence No Registration No
0	wner Code No. Receipt No. NRD
1. a.	Well Owner's First Name Last Name
b.	
· C.	
	Address 1400 Independence Avenue, SW City Washington State DC Zip 20250-0513 Telephone 202.720.5104
2. a.	Contractor's License No 89019 Contractor's Name Dennis J. Anderson
b.	Contractor's Email Address danderson@thielegeotech.com Drilling Firm Name Thiele Geotech, Inc.
0.	Address 13478 Chandler Road
	City Omaha State NE Zip 68138 Telephone (402) 556-2171
	Drilling Firm's Email Address www.thielegeotech.com
3. a. b.	Well location: SE % of the SW % of Section 10 , Township 11 North, Range 10E East/West, Cass County. Natural Resources District Lower Platte South
C.	The well is 1,004 feet from the (\square North/ \square South) section line and 1,814 feet from the (\square East/ \square West) section line.
C.	or Latitude Degree 40 Minute 55 Second 52.86
	Longitude Degree 96 Minute 17 Second 12.6
d.	Street address and subdivision, if applicable
	Block Lot
e.	Location of water use, if applicable (give legal descriptions)
f. g.	If for irrigation, the land to be irrigated is — acres. Well reference letter(s), if applicable: PMW-8 HHSS PWSID
	mits None Surface Water Permit Number
	othermal Permit Number Transfer Out-of-State Permit Number
	nicipal Permit Number Conduct Permit Number
	Il Spacing Permit Number Other Permit Number
Н	ISS NDEQ
Pu	pose of well (indicate one): Aquaculture Commercial/Industrial Dewatering (over 90 days)
-	Domestic Ground Heat Exchanger Groundwater Source Heat Pump Irrigation Injection
	Livestock X Monitoring Observation Public Water Supply (with spacing (46-638))
-	Public Water Supply (without spacing) Recovery Other (indicate use)
We	Ils in a Series.
	s this well a part of a series? X Yes; go to part b of this section. No; go to part 7 of this application
ъ. 1	f one or more of the wells in the series is currently registered, give the well registration number
c. I	fow many wells in the series are you registering at this time? 15
Des	lacement and abandoned well information.
	this well a replacement well? Yes X No
	egistration number of abandoned well If not registered, date abandoned well was constructed: (mm/dd/yy)
	eplacement well is feet from abandoned well. d. Abandoned well last operated (mm/dd/yy)
	riginal well pump column size: inches f. Completion of original well abandonment on (mps/dd/yy)
g. I	ocation of water use of abandoned well:

			222						fmw.	-8 (Cord.)
	mp Information Is pump install	ed at this	time? ·Ye	s X No			30. 330.00	neme n nem	,	
Is p	oump installed b	y well ov	vner in section 1	? Yes	No	Is pu	mp installed by	contractor in sect	tion 2? Yes	No.
Ifp	ump installed b	y pump i	nstaller, please fi	ll out license nur	nber below			5.00		-
b.	Pump Installer	's License	No	Pu	mp Installe	er's Na	me			
	Pump Installer	s Email A	Address							
	Pump Installer	s Firm N	lame					252		
	Pump Installer	s Firm A	ddress							
	City			State		Zip		Telephone		
			mail Address					10 1270 0. 000		
C.	Pumping Rate		gallons per	minute	Measure	d	Estin	nated		
	Drop pipe dian		TO 10 20 10 10 10 10 10 10 10 10 10 10 10 10 10					2 3	feet	
f.	Pumping equip	ment inst	alled (mm/dd/yy) _							
h.	This well is dea	igned and	i constructed to	oump less than 50	gpin 🔀	Yes	No			
). Well	Construction In	formation								
a. T	otal well depth	15		feet. b	. Static w	rater lev	/el:	feet.		
							tion began (mm/dd	3,3		
			ted: (mm/dd/yy) 04	SOURCE SOURCESSON			eter in inches	Top 8	Botton	n 8
			are Welded				hreaded X	Other		
g.	asing and sere	on Joints	ne weided				meaded A	Outer_		
0	Well Construct	on (Casir	~	d, e, & g measure	ments sho	uld be	in inches to three	decimal places		
	a		ь	, c	d		e	f f	B	h
1	Placement Dept in Feet	n	Casing or Screen	Inside Diameter	Outs		Wall Thickness	Screen Slot Size	Type of Material	Trade Name
rom	To		Baroon	Biamotor	Dian	Otto	THIORICSS	J	I IIII	
	4.5		Casing	2.00	2.375		0.1875	N/A	PVC	EMI
.5	14.5		Screen	2.00	2.375		0.1875	0.010	PVC	EMI
1	Grout and Grav	al Dools	an provident to the province	STATES AND ADDRESS.	and the second second	77.5. VA.			and the factor of the second district of the	
	nt Depth in Fee		Gr	out or		1		Material De	scrintion	
rom	То	7		el Pack				1114101141 200	soriphon	
0	2.2	Benton	nite Seal			Wyo	Ben Environp	lug Bentonite	Chips	
2.2	15	Sand/0	Gravel Pack			10/20	Washed Silic	a Sand		
	<u> </u>									
	Oralesia Mar	le T		Constructed For expense	N 16 200		Note that the second second	Jaggaran sabarah di diga di di	A CONTRACTOR	Committee of Species Service S
	Geologic Mater	ais Logge	ea .		1	,	a			
From	pth in Feet To		Descript	ion		From	th in Feet To		Description	
0	10	light g	ray silty clay			riom	10		Description	
10	15		lty clay with f	ine sand	_ _					
					_ _	+0			_	
X2572-75				(Additiona	l sheets m	ay be	submitted)	12		
			and the second s	THE RESERVE OF THE PERSON NAMED IN	Contract of the last		tendak menjeki menjenjen		Market State of the State of th	The second section of the sect
3. Iam	familiar with th	e informa	ation submitted o	n this registration	n, and to th	e best	of my knowledg	e it is true.		
3. Iam	familiar with th	e informa	ation submitted o	n this registration	n, and to th	e best	of my knowledge	e it is true.		
3. I am	familiar with th	ne informa	ation submitted o	n this registration	n, and to th	e best	of my knowledg	e it is true.		
3. Iam	familiar with the	ae informa	ation submitted o	in this registration		e best	of my knowledg	e it is true.		

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Mail to: DNR PO Box 94676 Lincoln, NE 68509-4676 Phone: (402) 471-2363

January 2004

STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES WATER WELL REGISTRATION

	FOR DEPARTMENT USE ONLY
Re	egistration Date Sequence No. Registration No.
O	wner Code No. Receipt No. NRD
a. b.	
c.	Address 1400 Independence Avenue, SW
_	
a.	Contractor's License No 89019 Contractor's Name Dennis J. Anderson Contractor's Email Address danderson@thielegeotech.com
b.	
	Address 13478 Chandler Road
	City Omaha State NE Zip 68138 Telephone (402) 556-2171
	Drilling Firm's Email Address www.thielegeotech.com
a. b.	Natural Resources District Lower Platte South
C.	The well is 512 feet from the (North/ South) section line and 2,037 feet from the (East/ West) section line.
	or Latitude Degree 40 55 Second 48
_	Longitude Degree 96 Minute 17 Second 9.78
d.	
	Block Lot
e.	Location of water use, if applicable (give legal descriptions)
f.	If for irrigation, the land to be irrigated is acres.
g.	Well reference letter(s), if applicable: PMW-9S HHSS PWSID
	Surface Water Permit Number
	anagement Area Permit Number Industrial Permit Number
	cothermal Permit Number Transfer Out-of-State Permit Number
M.	unicipal Permit Number Conduct Permit Number ell Spacing Permit Number Other Permit Number
11	HSSNDEQ
² u	urpose of well (indicate one): Aquaculture Commercial/Industrial Dewatering (over 90 days)
	Domestic Ground Heat Exchanger Groundwater Source Heat Pump Irrigation Injection
,	Livestock X Monitoring Observation Public Water Supply (with spacing (46-638))
	Public Water Supply (without spacing) Recovery Other
_	(indicate use)
	ells in a Series.
	Is this well a part of a series? X Yes; go to part b of this section. No; go to part 7 of this application
.]	If one or more of the wells in the series is currently registered, give the well registration number
. I	How many wells in the series are you registering at this time? 15
	placement and abandoned well information. Is this well a replacement well? Yes X No
	Registration number of abandoned well If not registered, date abandoned well was constructed: (mm/dd/yy)
	Replacement well is feet from abandoned well. d. Abandoned well last operated (mm/dd/yy)
e. C	Original well pump column size: inches f. Completion of original well abandonment on (mm/dd/yy)
1	ocation of water use of abandoned well:

									Pmw-95	(Cord.)
	ip Informatio			and the second						
			is time?Y							
			owner in section :				mp installed by	contractor in secti	on 27 Yes	No
			installer, please :							
0. 1	CHIND INSIST	er s Lacen	ise No	Pi	imp Install	z's Na	me			
1	remp Install	er's Email	Address							
- 1	rump install	a's rum	Name		-	_				
			Address	Ötet		91		Telephone		
	City		Email Address	Sian	-	Zap.		Tensbooms		-
			galions per	entionts.	Marine		Estin			
			inches	minute				DOUBLE	feet	
			stalled (con/40/y)				p Brand	_	1001	
			nd constructed to							
				barrels transcorers	o Bhon -	. 100		21 - 1 - V 21 - V		
	construction.	200								
	rtal well depr				b. Static u	rather Le	vel:	foot.		
					d. Wall Co	onstruc	tion began sowe	96 04/28/05		
			elotod: meresyo <u>0</u>		f. Bore ho	le dlam	eter in inches	Top 8	Botton	8
g. Ca	sing and Se	een Joints	sure Wolded	Gb	bet		Threaded_X_	Other		
, W	Vell Constru	tion (Cue	ring & Screen)- c,	d a A company	amount the	old blo	in inches to thus	decimal officer		
	a	ALLOW TOWN	B	e grace	d d		8	C doctions praces	1 g	h h
PI	scement De	pth	Casing or	Inside	Outs		Wali	Screen Slot	Type of	Trade Name
	in Post		Screen	Diameter	Diam	cter	Thickness	Size	Material	
om	To 5	-	Casing	2.00	2.375		0.1000	MILE	PVC	EMI
	9	-	Screen	2.00	2.375		0.1875	N/A 0.010	PVC	EMI
	1		por cen	2.00	21070		0.2070	0.010	1	10000
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STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES

hone: (402) 471-2363	WATERV	VELL REGISTRATION	ON	
	FOR DEPA	ARTMENT USE O	NLY	
Registration Date Owner Code No.	Sequence N Receipt No.	o	Registration No.	NRI
Well Owner's First Name Company Name USDA CE Consupportent Name Address 1400 Independence City Washington	PD FSA/CCC Avenue, SW State I		n Steve Gilmore	
Contractor's Email Address	State N	TE Zip 681:	Dennis J. Anderson 38 Teleptone (402) 556-21	71
b. Natural Resources District Low	er Platte South on the (North/E South 55 Minute 17 applicable — de (give legal descriptions gated is —	Second 48 Second 9,9 L acres.	rfs, Range 10E East/West, Cass 128 feet from the (East/E West) ot	
Permits None Management Area Permit Number Geothermal Permit Number Manicipal Permit Number Well Spacing Permit Number HHSS		Surface Water Permit Industrial Permit Nur Transfer Out-of-State Confact Permit Num Other Permit Number NDEQ	aber Permit Number ber	
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Replacement and abandoned well infine a. Is this well a replacement well? b. Registration number of abandoned w c. Replacement well is fee c. Original well pump column size c. Lecution of water use of chandoned	Yes X No ell tfrem abandoned well. inches	d. Abandoned w	sbandoned well was constructed: (cell last operated (

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			inches			e. Leng	th of drop pipe		feet	
f. P	umping equip	ment ins	talled (mm/dd/yy) _		Į	g. Pum	p Brand			
h. T	his well is de	signed an	d constructed to p	ump less than 50	gpm X	Yes	No			
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3. Iam fa	uniliar with th	e inform	ation submitted or	this registration	, and to the	e best o	of my knowledge	it is true.		
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Wate	er Well Contr	actor's Si	gnature	Date				er's Signature	annad.	Date
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STATE OF NEBRASKA DEPARTMENT OF NATURAL RESOURCES

WATER WELL REGISTRATION

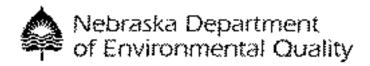
	FOR DEPARTMENT USE ONLY						
	Registration Date Sequence No. Registration No. Owner Code No. Receipt No. NRD						
1.	a. Well Owner's First Name Last Name b. Company Name USDA CEPD FSA/CCC c. Correspondent Name Attention Steve Gilmore						
	Address 1400 Independence Avenue, SW City Washington State DC Zip 20250-0513 Telephone 202.720.5104						
2.	a. Contractor's License No 89019 Contractor's Name Dennis J. Anderson Contractor's Email Address danderson@thielegeotech.com b. Drilling Firm Name Thiele Geotech, Inc. Address 13478 Chandler Road City Omaha State NE Zip 68138 Telephone (402) 556-2171						
	Drilling Firm's Email Address www.thielegeotech.com						
3.	a. Well location: SE ¼ of the SW ¼ of Section 10, Township 11 North, Range 10E East/West, Cass County. b. Natural Resources District Lower Platte South c. The well is 512 feet from the (North/ South) section line and 2,018 feet from the (East/ West) section line. or Latitude Degree 40 Minute 55 Second 48 Longitude Degree 96 Minute 17 Second 10.02						
	d. Street address and subdivision, if applicable						
	g. Well reference letter(s), if applicable: PMW-9D HHSS PWSID						
	Permits None Management Area Permit Number Geothermal Permit Number Transfer Out-of-State Permit Number Municipal Permit Number Conduct Permit Number Well Spacing Permit Number Other Permit Number HHSS NDEQ						
	Purpose of well (indicate one): Aquaculture Commercial/Industrial Dewatering (over 90 days) Domestic Ground Heat Exchanger Groundwater Source Heat Pump Irrigation Injection Livestock X Monitoring Observation Public Water Supply (with spacing (46-638)) Public Water Supply (without spacing) Recovery Other						
	Wells in a Series. a. Is this well a part of a series? X Yes; go to part b of this section. No; go to part 7 of this application b. If one or more of the wells in the series is currently registered, give the well registration number c. How many wells in the series are you registering at this time? 15						
	Replacement and abandoned well information. a. Is this well a replacement well? Yes X No b. Registration number of abandoned well If not registered, date abandoned well was constructed: (mm/dd/yz) c. Replacement well is feet from abandoned well. d. Abandoned well last operated (mm/dd/yz) e. Original well pump column size: inches f. Completion of original well abandonment on (mm/dd/yz) g. Location of water use of abandoned well:						

						33			Pmw	-90 (Cont
8. Pump a. Is	Information pump instal	led at this	time?Ye	s X No						
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Appendix B:

Nebraska Department of Environmental Quality Discharge Requirements for the Murdock Groundwater Treatment System



DISCHARGE REQUIREMENTS

For Treated Ground Water from a Remediation Project carried out by USDA under the Superfund Regulations

Personnt to Section (21 pf file Comprehensive Environmental Response, Compensation, and Lealabty Act of 1980, as attended (CESCLA), 42 U.S.C. §9601 et seq. and 40 Code of Federal Regulation (CER) Part 300,400. Table §19, Rules and Regulations Pertoining to the Issuance of Pertoin Under the National Pollutant Discharge Elimination System, constitute applicable requirements for the Mannat Grand Water Treatment System as described on this page. These discharge requirements were developed to treet file substantive requirements that apply to Superfund sites. The Accountainse Party identified on this page is responsible for ensuring compliance with the conditions set forth hereits.

NPRES Tracking Number:	NE0137464				
IIS 88e Wernher	71956_P				
Acquiriable Party:	Unided States Department of Agriculture Farm Service Agency				
Facility Name:	Muselick Granted Water Treatmont System				
Facility Location:	NE%, NW%, Section 15, Township 11 North, Range 10 E., Cass County				
AJsa Kaowa, as.	Fuurth and Wyuming Streets, Murduck, Nebraska 68407				
Receiving Water:	First is a land application using spreakler system.				
(Sale: Fregueroid:	April 4, 2805				
Discharge Anthoniostom	i instantionischen to discharge beconses effective op the date signed and remains as effect until terminated personat to dae conditions set (atth herein.				
	Vicenorsadom dated žungory 29, 1999 and signed by the Director, the andsrugned eat on the behalf of the Director.				
Signed this (key of					
	······································				
Patrick W. Ri	ice				
Assistant Dire	sclor				

April 4, 2005 Page 2 of 11

Table of Contents

PART I	DISCHARGE DESCRIPTION
PART I	I. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS
Α.	Requirements for Outfall 001
	II. OTHER CONDITIONS AND REQUIREMENTS
В.	Narrative Limits Additional Monitoring 4
C.	Modifications
APPEN	DIX A - STANDARD CONDITIONS THAT APPLY REGULATED DISCHARGES
Α.	General Conditions
B.	Management Requirements.
C.	Monitoring and Records.
D.	Reporting Requirements Operation and Maintenance
E	Operation and Maintenance
F.	Definitions
G.	Abbreviations 1

This authorization contains discharge limitations, management practices, and requirements for monitoring, record keeping and reporting. See pertinent sections in Parts I, II, III, and Appendix A of this document

April 4, 2005 Page 3 of 11

Part I. Discharge Description

This document specifically authorizes the discharge from the following outfall identified and described herein. The discharge characteristics need to be consistent with those described in the application and supplemental information submitted with it. Departmental approval is required for any alterations. This discharge consists of contaminated ground water from Outfall 001 to a pressurized spray irrigation system. The discharge shall be monitored and subject to the discharge monitoring requirements set forth in the following table.

Part II. Discharge Limitations and Monitoring Requirements

A. Requirements for Outfall 001

The discharge of contaminated ground water from Outfall 001 to a pressurized spray irrigation system is authorized and shall be monitored and limited as specified in the following table. Monitoring shall be conducted by after leaving the pressurized spray irrigation system. The Department may specify an alternative or more specific sampling point.

arameter	Storet #	Units	Discharge	Limitations	Sample Type	Monitoring Frequency
rarameter			Average	Maximum		
Flow	50050	MGD	Report	Report	Quarterly	Measured or Calculated
Carbon Tetrachloride	32102	μg/L	Report	Report	Quarterly	Grab
Chloroform	32106	μg/L	Report	Report	Quarterly	Grab
Other Parameter	Storet #	Units	Discharge Limitations		Monitoring	Sample
Other Larameter	Division in	Cana	Minimum	Maximum	Frequency	Type
рН	00400	Standard Units	6,5	9.0	Quarterly	Grab

April 4, 2015 Page 4 of 11

Part III. Other Conditions and Requirements

A. Narrative Limits

Discharges authorized under this permit:

- Shall not be toxic to aquatic life in surface waters of the State outside the mixing zones allowed in NDEQ Title 117 - Nebraska Surface Water Quality Standard;
- Shall not contain pollurants at concentrations or levels that produce objectionable films, colors, turbidity, deposits, or noxious odors in the receiving stream or waterway;
- 3. Shall not contain or produce any hydrocarbon sheens; and/or
- Shall not contain pollutants at concentrations or levels that cause the occurrence of undesirable or nuisance aquatic life in the receiving stream.

B. Additional Monitoring

The Department may require increases in the monitoring frequencies set forth in this permit to address new information concerning a discharge, evidence of potential non-compliance, suspect water quality in a discharge, evidence of water quality impacts in the receiving stream or waterway, or other similar concerns.

C. Modifications

 The basis for modification are set forth in NDEQ Title 119 - Rules and Regulations Pertaining to the Issuance of Permits Under the National Pollutant Discharge Elimination System. This authorization may be modified pursuant to this regulation.

April 4, 2005 Page 5 of 11

Appendix A - Standard Conditions that Apply Regulated Discharges

These general conditions are applicable to all regulated discharges under Title 119. These conditions shall not precent any more stringent requirements found elsewhere in this permit.

A. General Conditions

1. Information Available

All permit applications, fact sheets, permits, discharge data, monitoring reports, and any public comments concerning such shall be available to the public for inspection and copying, unless such information about methods or processes is entitled to protection as trade secrets of the owner or operator under Neb. Rev. Stat. §81-1527, (Cum. Supp. 1992) and Title 115, Chapter 4.

2. Duty to Comply

All authorized discharges shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit.

The permittee shall comply with all conditions of this permit. Failure to comply with these conditions may be grounds for administrative action or enforcement proceedings including injunctive relief and civil or criminal penalties.

The filing of a request by the permittee for a permit modification, revocation and re-issuance, termination or a notification of planned changes or anticipated non-compliance does not stay any permit condition.

3. Duty to Mitigate

The permittee shall take all reasonable steps to minimize, prevent or correct any adverse impact to the environment resulting from noncompliance with this permit, including such accelerated or additional monitoring as required by the NDEQ to determine the nature and impact of the noncompliant discharge.

4. Toxic Pollutants

The permittee shall not discharge pollutants to waters of the State that cause a violation of the standards established in NDEQ Titles 117, 118 or 121. All discharges to surface waters of the State shall be free of toxic (acute or chronic) substances which alone or in combination with other substances, create conditions unsuitable for equatic life outside the appropriate mixing zone.

5. Oil and Hazardous Substances/Spill Notification

Nothing in this permit shall preclude the initiation of any legal action or relieve the permittee from any responsibilities, liabilities or penalties under Section 311 of the Clean Water Act. The permittee shall conform to the provisions set forth in NDEQ Title 126, Rules and Regulations Pertaining to the Management of Wastes. If the permittee knows, or has reason to believe, that oil or hazardous substances were released at the facility and could enter waters of the State or any of the outfall discharges authorized in this permit, the permittee shall immediately notify the Department of a release of oil or hazardous substances. During Department office bours (i.e., 8:00 a.m. to 5:00 p.m., Monday through Friday, except holidays), notification shall be made to the Nebraska Department of Environmental Quality at telephone numbers (402) 471-2186 or (877) 253-2603 (toll free). When NDEQ cannot be contacted, the permittee shall report to the Nebraska State Patrol for referral to the NDEQ Emergency Response Team at telephone number (402) 471-4545. It shall be the permittee's responsibility to maintain current telephone numbers necessary to carry out the notification requirements set forth in this paragraph.

6. Property Rights

The issuance of this permit does not convey any property rights of any sort or any exclusive privileges nor does it authorize any damage to private property or neither any invasion of personal rights nor any infringement of federal, state or local laws or regulations.

7. Other Rules and Regulations Liability

The issuance of this permit in no way relieves the obligation of the permittee to comply with other rules and regulations of the Department.

8. Inspection and Entry

The permittee shall allow the Director or his authorized representative, upon the presentation of his identification and at a reasonable time:

April 4, 2005 Page 6 of 11

- To enter upon the permittee's premises where a regulated facility or activity is located or conducted, or records are required to be kept under the terms and conditions of the permit,
- To have access to and copy any records required to be kept under the terms and conditions of the permit.
- To inspect any facilities, equipment (including monitoring and control), practices or operations regulated or required in the permit, and
- To sample or monitor any substances or parameters at any location.

B. Management Requirements

1. Duty to Provide Information

The permittee shall furnish to the Department within a reasonable time, any information which the Department may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit; or to determine compliance with this permit. The permittee shall also furnish to the Department upon request, copies of records retained as a requirement of this permit.

2. Signatory Requirements

All reports and applications required by this permit or submitted to maintain compliance with this permit shall be signed and certified as set forth in this section.

- a. Permit applications shall be signed by a cognizant official who meets the following criteria:
 - 1) For a corporation: by a principal executive officer of at least the level of vice-president,
 - 2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively, or
 - For a municipality, state, federal or other public facility: by either a principal executive officer or highest ranking elected official.
- Discharge monitoring reports and other information shall be signed by the cognizant official or by an authorized representative.
- An authorized representative is designated by the cognizant official. The authorized representative is
 responsible for the overall operation of the facility (i.e., a plant manager, a well field operator or a
 wastewater treatment plant superintendent).
- Any change in the signatories shall be submitted to the Department, in writing, within 30 days after the change.
- Certification. All applications, reports and information submitted as a requirement of this permit, shall contain the following certification statement:

"I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations."

C. Monitoring and Records

1. Representative Sampling

Samples and measurements taken as required within this permit shall be representative of the discharge. All samples shall be taken at the monitoring points specified in this permit and, unless otherwise specified, before the effluent joins or is diluted by any other waste stream, body of water or substance. Monitoring points shall not be changed without notification to the Department and with the written approval of the Director.

- a. Composite sampling shall be conducted in one of the following manners:
 - 1) Continuous discharge a minimum of one discrete aliquot collected every three hours,
 - Less than 24 hours a minimum of hourly discrete aliquots or a continuously drawn sample shall be collected during the discharge, or
 - 3) Batch discharge a minimum of three discrete aliquots shall be collected during each discharge.

April 4, 2005 Page 7 of 11

- b. Composite samples shall be collected in one of the following manners:
 - The volume of each aliquot must be proportional to either the waste stream flow at the time of sampling or the total waste stream flow since collection of the previous aliquot,
 - A number of equal volume aliquots taken at varying time intervals in proportion to flow,
 - 3) A sample continuously collected in proportion to flow, and
 - If it is infeasible or non-representative of the pollutant loadings to conduct flow proportional sampling, the Department may approve the use of time composite samples.
- Grab samples shall consist of a single aliquot collected over a time period not exceeding 15 minutes.
 - All sample preservation techniques shall conform to the methods adopted in NDEQ regulations.

2. Flow Measurements

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be used to insure the accuracy and reliability of measurements. The accuracy of the measurement devices shall be calibrated and maintained to insure that they are consistent with the accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of */10% from the true discharge rates throughout the range of expected discharge volumes. Guidance in selection, installation, calibration and operation of acceptable flow measurement devices can be obtained from the following references:

- a. "Water Management Manual," U. S. Department of Interior, Bureau of Reclamation, Second Edition, Revised Reprint, 2001, 327 pp. This document is available from the National Technical Information Services (NTIS).
- "NPDES Compliance Inspection Manual," U. S. Environmental Protection Agency, Office of Enforcement and Compliance Assurance, Publication EPA 300-B-94-014 September 1994. This document is available from the National Technical Information Services (NTIS).

3. Test Procedures

Test procedures used for monitoring required by this permit, shall conform to the methods adopted in NDEQ regulations.

4. Averaging of Measurements

Averages shall be calculated as an arithmetic mean except:

- a. Bacterial counts which shall be calculated as a geometric mean, or
- b. Where otherwise specified by the Department.

5. Retention of Records

The accountable party shall retain records of all monitoring activities for a period of at least three years) as set forth in NDEQ Titles 119. The types of records that must be retained include, but are not limited to:

- a. Calibration and maintenance records.
- b. Original strip chart recordings,
- c. Copies of all reports required by this pennit,
- d. Monitoring records and information, and
- e. Electronically readable data.

6. Record Contents

Records of sampling or monitoring information shall include:

- The date(s), exact place, time and methods of sampling or measurements,
- The name(s) of the individual(s), who performed the sampling or measurements,
- c. The date(s) the analyses were performed,
- d. The individual(s) who performed the analyses,
- e. The analytical techniques or methods used,
- f. The results of such analyses, and
- g. Laboratory data, bench sheets and other required information.

April 4, 2005 Page 8 of 11

D. Reporting Requirements

1. 24-Hour Reporting

The accountable porty shall report to the NDEQ, within 24 hours of becoming aware of:

- a. Any noncompliance that may endanger the environment or human health or welfare,
- b. Any unanticipated bypass as set forth in NDEQ Titles 119 and/or 127,

All upsets as set forth in NDEQ Titles 119 and/or 127,

- any discharge to a POTW that causes a violation of the prohibited discharge standards set forth in NDEQ Title 119 or
- d. Any noncompliance of an effluent limitation in this permit.

Initial notification may be verbal. A written noncompliance notification shall be submitted as set forth in Section D 3 of this permit.

2. Written Noncompliance Notification

- a. The accountable party shall submit a written noncompliance report to the NDEQ:
 - 1) Within five days of becoming aware of any noncompliance with the:
 - (a) NPDES toxic pollutant offluent limitations or requirements set forth in this permit.
 - Within seven days of becoming aware of any other noncompliance with the NPDES requirements and/or effluent limitations set forth in this permit.
- b. The written notification shall be submitted on a noncompliance form supplied by the Department and shall include:
 - A description of the discharge and cause of noncompliance,
 - The period of noncompliance, including exact dates and times, or if not corrected, the anticipated time the noncompliance is expected to continue, and
 - 3) The steps taken to reduce, eliminate, and prevent the reoccurrence of the noncompliance.

The submittal of a written noncompliance report does not relieve the permittee of any liability from enforcement proceedings that may result from the violation of permit or regulatory requirements.

3. Quarterly Discharge Monitoring Reports (DMRs)

The permittee shall report the monitoring results required by this permit on a DMR form supplied or approved by the Department. Monitoring results shall be submitted on a quarterly basis using the reporting schedule set forth below, unless otherwise specified in this permit or by the Department.

Monitoring Quarters	DMR Reporting Deadlines			
January - March	April 28			
April – June	July 28			
July - September	October 28			
October - December	January 28			

If the permittee monitors any pollutant more frequently than required by this permit, using procedures specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted on the DMR. The frequency of the analysis shall also be reported on the DMR.

4. Changes in Discharge

Any facility expansion, production increases or process modifications which will result in new or substantially increased discharges of pollutants or a change in the nature of the discharge of pollutants must be reported by the permittee 180 days prior to the expansion, increases or modifications, either by amending his original application or by submitting a new application. This permit may be modified or revoked and reissued as a result of this notification to maintain compliance with applicable state or federal regulations.

April 4, 2005 Page 9 of 11

E. Operation and Maintenance

1. Proper Operation and Maintenance

The permittee shall, at all times, maintain in good working order and operate as efficiently as possible, any facilities or systems of control installed by the permittee in order to achieve compliance with the terms and conditions of this permit. This would include, but not be limited to, effective performance based on designed facility removals, effective management, adequate operator staffing and training, adequate laboratory and process controls, and adequate funding that reflects proper user fee schedules.

2. Treatment System Failure and Upset

An upset is an affirmative defense to an enforcement action brought for noncompliance with technologybased permit effluent limitations if the permittee can demonstrate, through properly signed, operating logs or other relevant evidence, that:

- a. An upset occurred and the specific cause was identified,
- b. That the facility was properly operated and maintained at such time,
- The Department was notified within 24 hours of the permittee becoming aware of the upset, and
- d. The accountable party took action to reduce, eliminate and prevent a reoccurrence of upset, including minimizing adverse impact to waters of the state.

Removed Substances

Solids, sludge, filter backwash or other pollutants removed in the course of treatment or control of wastewater shall be disposed of at a site and in a manner approved by the Nebraska Department of Environmental Quality. The disposal of non-hazardous industrial sludges shall conform to the standards established in or to the regulations established pursuant to 40 CFR, Part 257. If solids are disposed of in a licensed sanitary landfill, the disposal of solids shall conform to the standards established in Title 132.

F. Definitions

April 4, 2005 Page 10 of 11

Administrator: The Administrator of the USEPA.

Aliquot: An individual sample having a minimum volume of 100 milliliters that is collected either manually or in an automatic sampling device.

Biweekly: Once every other week.

Bimonthly: Once every other month.

Bypass: The intentional diversion of wastes from any portion of a treatment facility.

Daily Average: An effluent limitation that cannot be exceeded and is calculated by averaging the monitoring results for any given pollutant parameter obtained during a 24-hour day.

Department: Nebraska Department of Environmental Quality.

Director: The Director of the Nebraska Department of Environmental Quality.

Industrial User: A source of indirect discharge (a pretreatment facility).

Monthly Average: An effluent limitation that cannot be exceeded, calculated by averaging the monitoring results for any given pollutant parameter obtained during a calcular month.

Publicly Owned Treatment Works (POTW): A treatment works as defined by Section 212 of the Clean Water Act (Public Law 100-4) which is owned by the state or municipality, excluding any sowers or other conveyances not leading to a facility providing treatment.

30-Day Average: An effluent limitation that cannot be exceeded, calculated by averaging the monitoring results for any given pollutant parameter obtained during a calendar month.

Total Toxic Organics (TTO): The summation of all quantifiable values greater than 0.01 milligrams per liter (mg/l) for toxic organic compounds that may be identified elsewhere in this permit. (If this term has application in this permit, the list of toxic organic compounds will be identified; typically in the Limitations and Monitoring Section(s) or in an additional Appendix to this permit.)

Toxic Pollutant: Those pollutants or combination of pollutants, including disease causing agents, after discharge and upon exposure, ingestion, inhalation or assimilation into an organism, either directly from the environment or indirectly by ingestion through food chains will, on the basis of information available to the administrator, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological multiunction (including multiunctions in reproduction) or physical deformations, in such organisms or their offspring.

Upset: An exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee, excluding such factors as operational error, improperly designed or inadequate treatment facilities or improper operation and maintenance or lack thereof.

Volatile Organic Compounds (VOC): The summation of all quantifiable values greater than 0.01 milligrams per liter (mg/l) for volatile, toxic organic compounds that may be identified elsewhere in this permit. (See the definition for Total Toxic Organics above. In many instances, VOCs are defined as the volatile fraction of the TTO parameter. If the term "VOC" has application in this permit, the list of toxic organic compounds will be identified; typically in the Limitations and Monitoring Section(s) or in an additional Appendix to this permit.)

Weekly Average: An effluent limitation that cannot be exceeded, calculated by averaging the monitoring results for any given pollutant parameter obtained during a fixed calendar week. The permittee may start their week on any weekday but the weekday must remain fixed unless a change is approved by the Department.

"X" Day Average: An effluent limitation defined as the maximum allowable "X" day average of consecutive monitoring results during any monitoring period where "X" is a number in the range of one to seven days.

April 4, 2005 Page 11 of 11

G. Abbreviations

CFR: Code of Federal Regulations

kg/Day: Kilograms per Day

MGD: Million Gallons per Day

mg/L: Milligrams per Liter

NDEQ: Nebraska Department of Environmental Quality

NDEQ Title 115: Rules of Practice and Procedure

NDEQ Title 117: Nebraska Surface Water Quality Standards

NDEQ Title 118: Ground Water Quality Standards and Use Classification

NDEQ Title 119: Rules and Regulations Pertaining to the Issuance of Permits Under the National Pollutant

Discharge Elimination System

NDEQ Title 121: Effluent Guidelines and Standards

NDEQ Title 126: Rules and Regulations Pertaining to the Management of Wastes

NDEQ Title 127: Rules and Regulations Governing the Nebraska Pretreatment Program

NDEQ Title 132: Rules and Regulations Pertaining to Solid Waste Management

NPDES: National Pollutant Discharge Elimination System

POTW: Publicly Owned Treatment Works

μg/L: Micrograms per Liter

WWTF: Wastewater Treatment Facility